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An experiment in the area of related technical mathematics was conducted to determine the relative efficacy of programed self-instructional materials compared to the traditional methodology and text material. Eleven classes were involved during two semesters: one control group, seven experimental groups, and three semi-control groups (evening classes). The mean growth of each class was calculated by determining the difference in each student's final and pre-test scores. The experiment provided data which indicates that programed self-instructional material has been effective in teaching this particular subject at this particular level for this particular population. As a result of the experiment, it would appear that programed teaching presents information to the student equally as well as the traditional classroom methods, allows students to progress at their own ability rate, and provides students an opportunity to meet the particular course objectives with a considerable time saving. The experiment indicates that students can learn specific subject matter and acquire certain skills as effectively by the use of teaching machines as by the use of traditional methods. It is suggested that these machines be used with other types of audio-visual equipment to create a student self-tutoring laboratory. The machine should be a device for extending the teacher's effectiveness and a supplement to instruction so that teachers may devote their time to aspects of instruction not adaptable to machine teaching or presentation. Many tables and charts accompany text.

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TECHNICAL MATHEMATICS

INVOLVING

SELF-INSTRUCTIONAL MATERIAL

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June 1962

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SUMMARY

The San Diego City College, in cooperation with the State Department of Education, Bureau of Industrial Education, conducted an experiment in the area of Related Technical Mathematics. The experiment was to determine the relative efficacy of programmed self-instructional material compared to the traditional methodology and text material. The cost of the project was shared by the San Diego Unified School District and the California State Department of Education. Funds from the National Defense Education Act were made available under Title VIII. (See page 35 for cost figures.)

The experiment consisted of three phases. Phase I, involved the study of programming, the determination of the availability of programmed material in mathematics, and the relative benefits to the district of such a study. Six weeks were required for this phase.

Phase II was the planning stage. The course of study was broken down into very specific objectives. Programmed material and program holder (teaching machine) were selected based on the course objectives. The experiment was designed and measuring devices constructed prior to the selection of the programmed material. Approximately two months were required in developing the various measuring devices and forms necessary to the study.

Phase III involved the operation of and evaluation of the experiment.

There were eleven classes involved in the experiment - one control group, three experimental groups, two semi-control groups (evening classes) in the fall semester, and four experimental groups and one semi-control group in the spring semester. A description of the operational characteristics and of the methods of instruction will be found on pages 4 - 7.

The hypotheses to be tested were, (a) there shall be no significant difference in the mean gain (subject mastery or growth) of the eleven classes, and (b) there shall be no significant difference in the mean gain of the eleven classes in the three areas of Review Arithmetic, Beginning Algebra, and Applied Geometry.

A simple analysis of variance was used in the mathematical treatment of the data. The School and College Apptitude Test (S. C. A. T. - form 1a) scores were used to determine the ability levels of the classes. High school transcripts, where available, determined the mathematical backgrounds. There were ten tests administered during the semester. A pre-test was given to measure the initial comprehension. Eight criteria tests were used as a measure of subject area understanding. A final (post-test), which was a different form of the pre-test, was used to measure the subject mastery.

The mean growth of each class was calculated by determining the difference between each student's final and pre-test score.

An analysis of the S. C. A. T. scores indicated that there were no significant differences in the abilities of the fall classes. In the spring classes, however, there was a decided difference between the machine taught class mean ability level (lowest) and the three other day class means (see page 34).

FALL SEMESTER

The most important results of the fall experiment were:

1. The classes using programmed material were consistently higher on test scores.
2. The machine taught class met the objectives of the course in 44 hours as compared to 97 hours for the traditionally taught class.

3. The machine taught class made a significant gain in growth (subject mastery) over the traditionally taught class.

Students' reaction to programmed learning was favorable and their interest remained high throughout both the fall and spring semesters.

SPRING SEMESTER

The spring classes were definitely differing in mean ability as indicated by the results of the S. C. A. T. total scores. T-test comparisons were made between the four day classes (table XIV). The mean for the machine class (3344) on the S. C. A. T. total ranged from 12 to 17 points lower than the other three day classes. From the results of these t-test comparisons, one could predict that the other day classes would have test scores which would be significantly higher than the machine group. This, however, was not true.

Group to group comparisons showed that the machine group progressively became more nearly equated with the other classes on test performances. The one exception was between the machine class and the non-conventional class in Geometry. The non-conventional class had an average score 43 points higher than the machine class.

Again the first hypothesis regarding growth must be rejected between the fall control class and the spring machine class and between the fall control class and the pocketschool group. In both cases, there was a significant difference.

There were some significant differences in performances in the three areas of General Math, Algebra, and Geometry between the spring classes, but not between the fall control class and the spring classes.

A comparison of the number of hours required to meet the course objectives between the fall and spring machine class and the other classes resulted in the following:

Machine Class (fall)	44 hours
Machine Class (spring)	42 hours
Fall Control Class	97 hours
Other Spring Classes	99 hours

The machine classes met the course objectives in 46% (fall) and 42% (spring) of the time normally required.

CONCLUSIONS

This experiment has provided data which indicates that programmed self-instructional material has been effective in teaching this particular subject for this particular population at this particular level. Without more detailed study of these data, it would be difficult to isolate which factor(s) contributed to certain successes or failures. In general, however, one can conclude that programmed teaching:

1. Presents information to the student equally as well as the traditional classroom methods.
2. Requires responses which are measurable.
3. Aids in individualizing instruction and in conserving instructional time.
4. Substantiates earlier studies that point up the fact that errors in the field of exact sciences are directly related to reading comprehension.
5. Is accepted by the students as a means of learning fundamental concepts.
6. Allows students to progress at their own ability rate.
7. Provides students an opportunity to meet the particular course objectives with a considerable saving of time.

RECOMMENDATIONS

Since the experiment indicates that students can learn specific subject matter and acquire certain skills as effectively by the use of teaching machines as by the use of traditional methods, the following suggestions for the possible future use of this equipment are:

1. To use these machines along with other types of audio-visual equipment to create a student self-tutoring laboratory. A room for this purpose would preferrably be located in the vicinity of the library where students might check out various kinds of teaching aids. This laboratory might very well include teaching machines, record players equipped with earphones, tape recorders, and cubicles for taking proctored examinations. A variety of program materials could then be purchased for the library to use as supplementary enrichment or drill material in a variety of courses.
2. It is conceivable that we might ultimately abandon all efforts at group instruction for the purposes of remedying lack of competency in the fundamental subjects and particularly mathematics. Students upon failing a test might be required to improve their proficiency on their own, and to assist them we might well establish a mathematics clinic which would be equipped with teaching machines and suitable program materials for a variety of mathematical subjects.
3. It is presumed that teaching machines would be a valuable adjunct in any program where a considerable amount of instructional material has to be presented to students individually due to the fact that the group may be working on different projects while in the same class, or that the class may be made up of students at different levels of achievement or progressing at different rates which make group presentations impractical.
4. It would seem feasible to develop a more simple experimental design in order to attempt to isolate the various learning factors which contribute to the success or failure in performance through the use of programmed material.

5. It would also seem advisable to re-design this particular experiment--continue to collect data--and to statistically analyze these data in an attempt to determine the most effective use of these particular machines and this program.

In all of these situations the machine is looked upon as a device for extending the teacher's effectiveness and as a supplement to instruction in order that the teacher may devote his time and talents to those vital aspects of instruction not adaptable to machine teaching or presentation.

The technical division of the college will use the programmed material and machines as a supplemental teaching aid in the mathematics program.

The author wishes to express appreciation to all who gave so generously of their time and knowledge in the successful completion of this experiment.

Specifically, the author wishes to thank Dr. A. W. Nall, Dean of Arts and Science for his guidance and encouragement, Dr. Melvin Barlow, and Dr. William Schill, U. C. L. A., for verifying the mathematical analysis of these data, the Education Engineering Associates, and the Washington University Human Resources Research Department.

Reported by: Ira D. Dodge, Mathematics Department, San Diego City College

June 1962

TECHNICAL REPORT

CHAPTER I

A study of the practicability and application of programmed self-instructional material in teaching Related Technical Mathematics.

STATEMENT OF THE PROBLEM

The problem of this study was to determine if significant differences did occur between groups of students taught by traditional methods and groups of students taught through the use of self-instructional material. The subject area chosen was Related Technical Mathematics 14. This is the basic mathematics subject required of all technical and vocational students in the San Diego City College who are majoring in a skilled trade field.

Review Arithmetic, Beginning Algebra, and Applied Geometry are the three subject areas covered by the course objectives. It was recognized at the out set that with few exceptions, all of the students had been exposed to these areas of mathematics in prior educational experiences and that the experiment would be comparing differing methods of instruction related to a re-learning situation.

Limitations of the Study

The greatest limitation of the experiment was to locate programmed material which (a) would meet the objectives of the course of study, and (b) was programmed in such a manner as to include technical and/or skilled trade vocabulary and practical problems related to these vocational areas.

Since the author was unable to locate such programmed material, it was decided to use a program based on the fundamental mathematical concepts and processes with the vocabulary and practical application being the responsibility of the particular major trade teachers.

A limitation imposed on the study was the expense of the automated devices and programs. Since the prices of the machines and programs were high and their effectiveness had not been investigated, lease arrangements were made with the providing company. The school district had the option of applying all lease money to the ultimate purchase of the machine(s) and program(s).

Another limitation was in attempting to establish a randomly selected population. Since trade and industrial students at the San Diego City College have three-hour blocks of shop or laboratory time within the framework of their over-all schedule, it was decided to allow the students to enroll in the Math 14 class of their choice. It was then decided which classes would be the experimental and control groups.

CHAPTER II

Study Procedure

Phase I - The author was requested by Mr. Joseph Stephenson, Dean of Trade and Industrial Education at the San Diego City College, to conduct a study as to the feasibility of using programmed material (teaching machines) in teaching Related Technical Mathematics 14. A committee was organized and consisted of Dr. Melvin Barlow, U. C. L. A., Mr. Charles W. Patrick, Assistant Superintendent in Charge of Post High School Education, San Diego City Schools, Mr. Mack Stoker, Regional Supervisor of Trades and Technical Education, Mr. Richard Nelson, Special Supervisor of Technical Education, Mr. Stephenson, and the author. Operational procedures were outlined and the budget was developed during the first meeting. The study started May 1, 1961, with recommendations to be made June 16, 1961. Another committee, with representation made up of local school administrators, was formed to determine the extent to which the district would become involved financially, the magnitude of the study, and the benefits of the study to the district. The local committee members were Dr. George Geyer, Associate Superintendent, Mr. Charles Patrick, Dr. William Stegeman, Assistant Superintendent of Curriculum, Mr. S. L. Guiliani, Assistant Supervisor of Secondary Education, Mr. Joseph H. Stephenson, Mr. Donald Andersen, Head of Mathematics Department, City College, and the author.

It was the decision of this committee to consult with Dr. Robert F. Mager, Varian Associates, Palo Alto, California, regarding some of the major factors of the study. Dr. Mager came to San Diego and met with the committee. The results of this meeting were:

a. encouragement in conducting the study.

b. development of specific objectives for a course of study.

c. development of cost of programmed material.

d. establishment of list of programs and devices which were on the market.

e. establishment of experiment design.

f. establishment of the problems generally encountered in such an experiment.

In cooperation with Mr. Donald Andersen, Chairman of the Mathematics Department, specific objectives of the course were developed. Having been reviewed by Dr. Robert Mager, the objectives were refined and duplicated.

Phase II - The pre-test and the criterion tests were then developed. All the tests were the multiple choice (five selections) type of test.

Several teaching machines and programs were studied and rejected, mostly due to the programs not meeting the objectives of the course. The machine selected was of the linear type. The firm was able to supply or prepare programmed material satisfactory for this particular study.

The most important decision was the choice of the teacher of the complete control group. The teacher selected for this class had taught this particular subject for many years. His practical background as a skilled craftsman, combined with a high degree of effective methodology, established a high standard for comparison.

The six fall classes were arbitrarily designated as follows:

Group		Section	Time	Days	Teacher
I	(Control)	3346	7:10-8:00 am	MWF	Day
II	(Machine)	3347	8:10-9:00 am	MWF	Dodge
III	(Programmed Text)	3348	1:40-2:30 pm	MWF	Dodge
IV	(Traditional with objectives)	3349	2:30-3:30 pm	MWF	Johnson
V	(Control)	7534	6:30-9:30 pm	M	McIver
VI	(Control)	7535	6:30-9:30 pm	T	Ullrich

The students were to have no pre-knowledge of the experiment plans and would enroll in the class which they felt best fitted their over-all schedule. The characteristic and operation of the fall classes were:

Group I - Control group. The methodology was the traditional group teaching using the text Practical Mathematics by Palmer and Bibb. The teacher was given a breakdown of the areas covered by the criterion tests and allowed to give the tests at his discretion. Since it was apparent that the students would quickly realize that they were involved in an experiment, the experiment was explained to this and the other classes during the first class meeting.

Group II - Machine group. Students in the second group were told that the recommended text would not be required and that they would do all their work on the machines, and were specifically requested not to study outside of class in order to determine the effectiveness of the program. At the third meeting, the students were scheduled for three hours per week (within the frame-work of their over-all schedules). It later developed that this resulted in a weekly student-machine time of 25 hours ranging from five students some hours to one at other times. After the first week, an additional machine was installed which reduced the time spread and better fitted the students' schedules.

The machine used in the experiment was an electronically controlled slide projector which projected images on a self-contained screen. The slides or frames were in pairs consisting of an information frame and a problem frame. The problem frame contained five problems with ten possible answers. Guessing answers were eliminated since there was only one in 30 plus thousand chances of getting all answers correct. If one or more problems were wrong, the machine regressed to the preceeding information frame. The machine tabulated only the number of times the machine regressed. If the question(s) or problem(s) were

answered correctly, the machine advance to new information.

The class was (a) instructed on the operation of the machines, (b) given the basic principles involved, and (c) told that tests would be required both on the machine and written, but that the written test would be the major factor in determining the semester grade.

Group III - Pocketschool group. This class was designed to meet with the teacher one class hour per week at which time individual instruction was available to those who needed help or to take tests. The rest of the time was spent outside of class studying on their own. After the third week, the class was changed to a completely unstructured schedule since none of the students indicated need for assistance. Individual help was provided at any time and tests given whenever a student was ready.

The Pocketschool Series (programmed booklets) was integrated with the traditional text since the programmed material did not cover all course objectives. Each student received a set of specific course objectives and assignment sheet showing which areas of the course were covered by which texts. (See table XII, page 32).

Group IV - Traditional/Objectives. This group was similar to the control group. The only difference was that each student received a set of specific course objectives in written form for constant reference.

Group V and VI - These two groups were extended day classes and were considered as control groups. However, due to the differing characteristics of the students and of the class operations (meeting one night a week with the teacher unavailable except during class meetings), the comparability of the data obtained from these two groups was questionable.

The experiment was continued into the spring semester and involved students new to the program. This part of the experiment was an attempt to apply additional methods of comparing the use of self-instructional material with traditionally taught classes. The design was as follows:

Group I - Semi-control. The group was taught in the traditional manner, meeting one night a week for three hours, using the prescribed text and the usual homework.

Group II - Machine Taught. A completely unstructured group who "checked out" a machine and program, similar to a library book, from a clerk. Since the material in Math 14 is of a review nature, the objectives of this particular experiment is to determine whether or not teaching machines could be placed in a library and the student satisfactorily review material without the aid of an instructor.

Group III - Programmed and Traditional Text. A continuation of the first semester experiment, but met three hours a week at 2:50 to 3:40 p.m.

Group IV - Conventional Methodology and Text. Teaching machines to be used where desirable for those of high and low ability, for additional enrichment and/or drill. This class met for three hours a week at 12:50 p.m.

Group V - Non conventional group. Taught by an instructor with programming experience, using any aids at his command, except teaching machines. The objectives of this experiment were to determine whether it was the program or the machine which determined any significance. This class met three hours a week at 7:00 a.m.

Note: All groups in the experiment were furnished with specific objectives.

Phase III - Method of Obtaining Data: (Fall)

Pre-test - The author administered the pre-test to each of the six classes prior to any instruction. The pre-test was a different form of the final examination.

Criterion Tests - There were eight criterion tests (two different forms of each). These tests were given to all groups (except II and III) at the discretion of the individual teachers. These teachers had no prior knowledge

of the test content. However, each teacher was furnished with the areas covered by each test.

In groups II and III, every student was given these tests as each completed the areas covered by the respective test. Even though students took the tests at different times, there was no apparent exchange of test knowledge between students since test scores tended to decrease generally as more of the students completed each test. This trend might be expected (accepting that no prior knowledge was available) as the more capable students usually progress more rapidly and make higher scores.

Final Test - This test was designed by the Supervisor of Mathematics, San Diego School District, who was not involved in the experiment. He used the pre-test to determine the types of problems that were to be included. It was assumed that comparison between pre-test and the final would give the growth gained by each group and each student.

CHAPTER III

TABULATION AND ANALYSIS OF DATA

The following data were collected:

a. Student's name and identification number.

b. Trade major.

c. Age.

d. Semesters of High School math - these data included the ninth grade.

e. Average grade in high school mathematics - same as (d).

f. S. C. A. T. scores (School and College Apptitude Tests). The scores used were the verbal, quantitative, and the total.

g. Pre-test score - this score was from a different form of the final test. The problems exemplified the objectives of the course.

h. Criterion test scores - these scores were taken from tests designed to measure the basic concepts as specified by the objectives.

i. Final test score - taken from a test similar to the pre-test.

j. Hours - (1) the number of hours each student was engaged in learning from the machines was recorded (to the nearest five minutes) and (2) the number of class hours in non-machine classes, plus hours engaged in out-of-class assignments.

Test scores and the other information were placed on I. B. M. cards. The cards were then programmed through a computer to obtain the following for the total of all groups and for each class:

a. data observations counts for sums, sums of squares, and cross product sums.

b. sums

c. sums of squares and cross product sums

d. means

e. standard deviations

f. variances and covariances

g. correlation coefficients

A simple analysis of variances of the variables shown below was computed for all classes. The mathematical treatment involved was:

$$SS_{bg} = \sum (N M^2) - N_t M_t^2$$

$$SS_{wg} = SS_t - SS_{bg}$$

$$SS_t = \sum (X^2) - N_t M_t^2$$

$$MS_{bg} = \frac{SSbg}{N_g - 1}$$

$$MS_{wg} = \frac{SS_t}{N_t - N_g}$$

$$F \text{ (ratio)} = \frac{MS_{bg}}{MS_{wg}}$$

A total of 109 students was enrolled in the six fall classes--ranging from eleven in one of the extended day classes to 24 in the machine taught class.

The spring initial population was 103. The classes ranged in size from 10 to 31.

Though the validity of the data on any one test might be questionable with such small populations, the combined test data could justifiably be considered to be accumulative, since the controls and techniques remained constant for each class throughout the experiment.

Comparing the verbal, quantitative, and total scores on the S. C. A. T. test, the six fall and spring groups seemed to be fairly well equated.

		Verbal		Quantitative	
GROUP	N	MEAN	S. D.	MEAN	S. D.
Spring 1960-61	52	290.3	13.9	298.0	12.66
Fall 1961-62	109	289.2	13.4	301.3	11.05
Spring 1961-62	92	283.9	15.6	286.9	14.79

This was less than significant at the 5% level.

Individual I. Q.'s were not available on all students since all the students were not from the San Diego School District. However, the correlation between I. Q. and S. C. A. T. total scores is approximately .65 to .70. Therefore, there is less than 25% (approximate) surety that an I. Q. can be determined from the S. C. A. T. scores. One can assume in general, however, that higher I. Q.'s accompany higher S. C. A. T. scores.

From the S. C. A. T. "Q" scores, the following number of students in each class were required by school policy to enroll in Mathematics A (review) prior to enrolling in Math 14 or any other mathematics course.

Class	N (Total)	N (Math A)	Per Cent
3346	22	5	22.7
3347	24	5	20.8
3348	17	2	11.8
3349	18	4	22.1
7534	13	3	23.1
7535	14	3	21.4
Total	108	22	20.4

Variable 19, (semesters of high school math) was the only factor which differentiated the fall groups significantly. This was at the 1% level of confidence for 30 d.f. The range of the mean between the six classes on this item was from 4.4 to 6.1 with a total mean of 5.3 and a standard deviation of 1.9. However, comparing the mean of the number of semesters of high school math (highest and lowest) with the mean of the scores on the pre-test for the same two classes shows that for these particular students the number of semesters of high school math was not a very effective predictor of math competency on the pre-test.

Section	Type	H.S. Math Mean	Pre-test S.D.	Pre-test Mean	S. D.	Corr. Pre-test H.S.M.
3349	Trad./Obj.	6.1	1.3	35.9	16.1	0.542
7535	Control	4.4	0.8	33.1	13.5	-.098
Total group		5.3	1.9	37.5	15.3	0.436

CHAPTER IV.

CONCLUSIONS AND RECOMMENDATIONS

Fall Semester

In the preliminary stages of the experimental design, it was decided that the data obtained from the evening classes would not be used in the final analysis. The characteristics of the students and class operations are different than the day classes. Also, though the day and evening classes were equated in the beginning, the excessive drop-outs in the evening classes (page 30) meant that data from these classes would not be valid.

First Hypothesis

The first hypothesis that there shall be no significant difference in the mean gain (subject mastery) of the four classes must be rejected. The machine class showed the greatest growth (15.4 points) of the day classes (pages 53 & 57).

Growth (subject mastery)

A "T" score was computed for the difference between the control class and the machine taught class (the two classes with the greatest difference of mean growth).

The pre-test and the post-test were given the same mathematical treatment as the growth (see table XIV). There was no acceptable degree of confidence in either case, which was also indicated by the analysis of variance.

The mathematical treatment was:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$

where $\bar{X}_1$ = mean of group I

$\bar{X}_2$ = mean of group II

and

$$S = \sqrt{\frac{\sum (X_1 - \bar{X}_1)^2 + \sum (X_2 - \bar{X}_2)^2}{N_1 + N_2 - 2}}$$

$t_{1,2}$ = 2.825 which is significant at better than 1% level of confidence for 38 degrees of freedom.

Computations were also made comparing the control class with both the pocketschool and the traditional with objectives classes. The results were:

Comparisons	Growth	t-score	df	Level
3346 (control) 3348 (pocketschool)	4.88 9.00	1.158	28	$t > 10\%$
3346 (control) 3349 (trad. w/obj.)	4.88 12.13	1.749	31	$5\% < t > 10\%$

Comparing the performances of the day classes (see table III,page 24) on the 16 variables related to test scores, the machine class means were the highest in five, and second in six of the variables. The Pocketschool group was highest in eight and second in four of the variables. Between these two groups using programmed material, they were highest in 15 and second in 14 of the 16 variables. This would seem to indicate that programmed material is effective.

A comparison of the relative position of each of the four day classes, based on the means and standard deviations of the various test scores is shown in the following table: (Refer to table III, page 24)

	Means				S. D.'s			
Class	1	2	3	4	1	2	3	4
Control	1	0	7	8	0	1	10	5
Machine	5	6	1	3	14	1	0	1
Pocketschool	8	4	3	0	0	2	5	9
Trad. W/Obj.	2	6	5	3	2	12	1	1

(The meaning of the positions - the number one, under mean indicates that this is the largest mean for a particular variable. The number one under standard deviation indicates the smallest deviation for a particular variable. The numbers under these positions indicates the number of occurrences for this position in the 16 variables. In two instances, the machine class and the pocket-school class had equal highest means.)

Though significance cannot be attached to the means at the 1 or 5% level of confidence the two classes using the self-instructional material were consistently higher. A study of the standard deviations also reveals a consistently greater homogeneity.

Second Hypothesis

The second hypothesis that there will be no significant difference in the mean gain in the three areas of Review Arithmetic, Algebra, and Geometry must be accepted. Again, however, comparing the means of the day classes, the machine class was first in Review Arithmetic, tied for first in Algebra, and last in Geometry. The Pocketschool was second in Review Arithmetic, tied with the machine class in Algebra, and second in Geometry.

T - scores were computed for the three areas comparing the control class with the machine class. The t - scores were:

Review Arithmetic	=	2.265	3% for 43 df.
Algebra	=	1.41	10% for 38 df.
Geometry	=	0.503	not significant

The most significant factor resulting from the experiment was the comparison of the number of hours required by the classes to meet the objectives of the course.

There were 53 class meetings in the Fall semester for the Math 14 classes; this included time for testing (pre-test, eight criterion tests, and the final). Assuming that the students spent one hour on out-of-class assignments for every class hour, the total student time in a normal class operation would be 53 X 50 minutes plus 53 X 60 minutes.

For the control, traditional w/objectives, and the extended day classes, the total time was 44 hours - 12 minutes in class and 53 hours out-of-class assignments or 97 hours.

The machine taught class student time on the machines ranged from 30 hours - 0 minutes to 45 hours - 35 minutes, with a mean of 36.71 hours. The ten written tests (45 minutes each) required an additional 7.5 hours for a total of 44.21 hours.

The Pocketschool group was an unstructured class and there was no way of accurately determining the number of hours the students were involved in study.

Comparison of Number of Problems Worked by the Various Fall Classes

Machine Class - There was a total of 24 teaching sets and seven drill sets. Each teaching set contains 18 question frames having five questions and/or problems per frame. The drill sets contain 36 frames with five questions and/or problems per frame. The number of questions answered on each frame may be controlled by a selector switch.

The teacher for this class attempted to pace the material in order that all students were able to complete the entire course in the allotted time. The machine company programmer indicated that the material provided for this course normally would be (a) 70% of a semesters course in General Math, (b) 60% of a semesters course in Algebra, and (c) plus the eight sets on Applied Geometry. This would be true, however, only if the students worked all five questions on each frame. The machine class worked the following number of problems:

	Gen. Math		Algebra		Geometry		Total	
	N		N		N		N	
	Sets	Worked	Sets	Worked	Sets	Worked	Sets	Worked
Teaching	10	612	8	432	6	108	24	1152
Drill	4	288	1	72	2	72	7	432
					Total		51	1584
					Mean/set		51.1	

Total number of problems contained in the sets were 3420. The students worked 1584/3420 or 46.4% of the total.

The machine counts the number of errors made. One or more errors on each frame counts as one. The errors were as follows:

General Math		Algebra	Geometry
Total	633	1153	615
Mean/Stud.	30.1	52.4	23.5

Control - The instructor of this class did not assign specific problems to be worked. He indicated to the students the types of problems which they should be able to work. The students then individually selected problems from the text.

Traditional With Objectives - The students in this class were assigned specific problems; a maximum of ten problems per objective which would be 700 to 750 problems total.

Pocketschool - These students were free agents as to their study hours and the number of problems worked. There would be no accurate method of determining the number of problems worked.

Evening - The students in these two classes were given specific assignments and the total number of problems would be comparable to the Traditional With Objectives class.

Spring Semester

The method of and types of data collected for the spring classes remained the same as the fall portion of the experiment.

There were definite differences in the mean ability levels in the spring groups (page 34). The machine class S. C. A. T. total ranged from 12 to 17 points lower than the other spring classes and the fall control group. T-tests which were computed for all the spring data, showed a significant difference between the fall control and the spring machine class (0.1% level of confidence for 48 degrees of freedom), and between the machine group and the non-conventional (0.1% level of confidence for 50 degrees of freedom) and between the non-conventional and the pocketschool (1% level of confidence for 34 degrees of freedom).

With this difference in ability between these groups, it could be expected that similar differences would occur on any of the ten test performances. There were significant differences but these differences in general occurred between

different groups. On most tests, the machine class performed much better than was expected.

The first hypothesis related to mean gain (growth) must again be rejected. Both the machine class (2% to 5% level of confidence for 32 degrees of freedom) and the pocketschool class (1% to 2% level of confidence for 24 degrees of freedom) did significantly better than the fall control class. Comparing just the spring classes, however, there were no significant differences.

The second hypothesis must be accepted when comparing the fall control class with the spring classes on their performance in the three areas of General Math, Algebra and Geometry. There were significant differences within the spring classes in these three areas, but these were inconsistent from area to area and between groups.

Again one of the most significant factors was that of the amount of time required to meet the objectives of the course. The machine class mean for the number of hours was 42 and ranged from 20 hours and 15 minutes, to 70 hours. The other spring classes required 99 hours.

Post Data - Fall Classes

A follow-up of the fall Math 14 students was made as to their relative performance in either Math 17 (for electronic majors) or Math 15 for all other majors.

Data were collected of all test scores up through the first four months of these subjects. These scores were then compared based on the instructional treatment received in Math 14. All scores were converted to percentage scores. The result of the analysis was:

Class	N	$\bar{M}$	t-test	df	Significance
3346	8	66.9	(6.7) 0.910	17	None
3347	9	57.9	(6.8) 0.979	13	None
3348	5	53.6	(8.9) 1.080	13	None
3349	8	68.3			

Comparisons could not be made between student performances in Math 17 and Math 15 since the two courses have differing objectives and standards.

TABLES

Means by trade
Fall - 1961-62

TRADES	NUMBER	AGE	SEMESTERS IN H. S. MATH	AVERAGE GRADE IN H. S. MATH	S.C.A.T. V	S.C.A.T. Q	S.C.A.T. T
ALL TRADES	109	22.1	5.3	4.5	289	301	295
AIRCRAFT	4	18.3	6	2.5	289	302	295
ARCH. DRAFT.	2	18	5.5	3.5	281	302	291
AUTO BODY	2	19	8	5	285	302	292
AUTO MECH.	7	18	6	4.3	289	303	298
COMM. ART	15	20	3.2	4.5	292	297	295
DIESEL	1	18			294	307	299
ELECTRICITY	6	21.7	5.4	4.0	280	295	290
ELECTRONICS	41	23.1	5.1	3.9	291	303	296
MACH. SHOP	3	28.7	3.5	4.5	285	285	285
MATH	1	19	4	6	293	299	296
MECH. DRAFT.	8	19.3	5.4	4.4	280	295	287
PRE-ENGR.	1	36			284	286	285
PRE-MED. TECH.	1	19	4	6	283	314	297
POLICE SCIENCE	3	22	6.3	5.3	293	311	301
REFRIGERATION	1	18	6	5	295	307	300
TECH. ILL.	5	20.0	5.8	5.2	286	304	294
TOOL DESIGN	2	32	5	5.5	284	301	293
WELDING	2	19	6	3.5	293	293	293

TABLE I

Means by trade

Spring 1961-62

TRADES	Number	Age	Semesters of High School Math	Average Grade in High School Math	S.C.A.T. V.	S.C.A.T. Q.	S.C.A.T. T.
ALL TRADES	91	25.3	5.5	5.4	286	293	290
AIRCRAFT	2	24.5			314	304	309
AUTO BODY	2	18.5	5.0	5.0	273	283	279
AUTO MECH.	5	28.4	7.0	4.5	280	285	280
CARPENTRY	2	19.0			260	268	267
COMM. ART	6	20.0	6.0	6.0	285	288	286
DIESEL	1	18.0	7.0	5.0	286	311	
DRAFTING	1	36.0			290	294	297
ELECTRICITY	10	20.1	7.1	6.0	280	303	287
ENGR. TECH.	2	20.5	4.5	5.5	288	290	289
FIRE SCIENCE	1	36.0	6.0	5.0	305	310	306
GEN. ELEC.	38	30.8	4.7	5.5	290	296	293
MACHINE SHOP	2	20.5	4.0	8.0	281	295	288
MECH. DRFTG.	8	29.0	4.5	4.5	287	286	288
POLICE SCIENCE	2	26.5	8.0	8.0	312	312	312
RADIO T-V	2	49.0			279	285	281
REFRIGERATION	3	27.0	6.0	4.0	278	287	284
TECH. ILLUS.	10	18.5	7.1	5.1	285	295	290
TOOL PLANNING	1	48.0	6.0	6.0			

TABLE II

All six classes - N, Mean, & S.D.

Fall Classes 1961-62

		Pre-Test	Test 1	Test 2	Test 3	Test 4	Gen. Math Total	Test 5a	Test 5b	Algebra Total	Test 6	Test 7	Geometry Total	Criteria Tests Total	Final	All Test Total	Semester Grade
Population	All	104	103	103	102	98	97	85	84	84	84	83	83	82	81	81	81
Control	3346	22	22	22	22	22	21	19	18	18	17	18	18	18	18	18	18
Machine	3347	24	24	24	24	24	24	22	22	22	22	22	22	22	22	22	22
Pocketschool	3348	16	16	16	16	15	15	15	15	15	13	13	13	13	13	13	13
Trad. W/Obj.	3349	18	18	18	18	17	17	16	16	16	16	16	16	16	16	16	16
Evening	7534	11	11	11	10	9	9	7	7	7	7	7	7	7	7	7	7
Evening	7535	13	12	12	12	11	11	6	6	6	9	7	7	6	5	5	5
Mean	All	37.6	80.5	78.9	71.0	60.7	291	62.9	73.8	137	64.7	45.1	109	544	51.2	596	3.37
	3346	38.2	77.1	75.0	66.8	51.4	271	61.1	65.0	128	61.8	45.0	103	507	47.0	554	3.11
	3347	39.7	82.8	82.9	78.1	62.1	304	61.8	80.9	143	61.4	37.3	97.7	545	54.3	603	3.41
	3348	40.8	82.8	78.8	66.9	64.0	293	68.0	74.7	143	66.5	43.8	110	568	54.4	623	3.46
	3349	35.9	78.8	79.4	69.4	56.5	284	63.8	75.3	139	70.0	42.5	113	535	46.3	581	3.06
	7534	32.6	81.5	78.2	81.5	66.7	312	76.4	70.0	146	65.7	61.4	127	586	56.3	642	4.00
	7535	35.1	81.0	78.3	63.3	73.6	295	41.7	71.7	113	65.6	61.4	134	570	53.4	632	4.00
S. D.	All	15.5	9.49	14.0	21.2	26.5	55.0	21.1	20.3	35.3	18.5	26.2	38.3	105	15.0	117	1.01
	3346	18.3	10.2	15.4	21.7	31.4	64.9	19.5	20.7	37.4	20.3	25.9	41.4	130	17.5	145	0.99
	3347	10.9	8.60	10.2	16.1	23.1	36.0	21.9	13.7	28.0	15.2	20.9	28.6	77.1	10.2	79.9	0.94
	3348	19.3	6.89	17.5	24.2	23.9	64.1	21.4	25.4	42.4	23.6	31.5	49.2	110	15.2	122	1.08
	3349	15.6	8.43	13.0	21.6	23.7	56.3	16.3	19.3	33.6	17.0	25.1	36.7	109	17.6	123	0.97
	7534	13.4	6.88	12.3	16.9	16.3	38.4	10.3	15.8	24.2	8.21	29.5	32.4	91.4	11.1	102	0.76
	7535	11.3	13.2	12.8	20.4	28.7	50.1	25.6	21.1	32.1	19.2	12.5	16.8	53.1	8.59	59.1	0.89

TABLE III

All six classes - N, Mean & S. D.

Fall 1961-62

		AGE	SEMESTERS OF H. S. MATH	AVE. GRADE IN H. S. MATH	S.C.A.T. V	S.C.A.T. Q	S.C.A.T. T
POPULATION	ALL	109	77	77	108	108	108
(N)	3346	22	17	17	22	22	22
	3347	24	17	17	24	24	24
	3348	17	12	12	17	17	17
	3349	18	13	13	18	18	18
	7534	14	10	10	13	13	13
	7535	14	8	8	14	14	14
MEAN	ALL	22.1	5.3	4.5	289.2	301.3	295.1
CONTROL	3346	21.5	5.0	4.6	287.5	300.7	293.9
SPEED	3347	21.6	5.1	4.3	288.1	302.8	295.0
POCKET SCH.	3348	21.2	5.9	4.0	291.4	302.2	296.5
W/OBJ.	3349	19.6	6.1	3.8	290.0	301.3	296.1
EVENING	7534	25.6	4.9	4.0	285.8	300.2	292.8
EVENING	7535	24.9	4.4	4.3	293.3	299.6	296.2
S.D.	ALL	6.5	1.9	1.8	13.4	11.1	8.9
	3346	7.1	2.0	2.0	12.7	9.5	7.6
	3347	5.8	2.2	1.8	14.7	10.3	8.6
	3348	6.5	2.1	1.3	14.5	12.7	11.2
	3349	2.1	1.3	2.0	15.1	12.0	9.3
	7534	8.8	1.7	1.8	12.0	12.6	8.0
	7535	6.5	0.8	1.7	10.2	11.5	9.2

TABLE IV

COMPARISON OF STUDENTS IN EACH CLASS WHO TOOK MATH A PRIOR TO MATH 14 WITH THEIR RESPECTIVE CLASS PERFORMANCE - Fall 1961-62

N (Math A) 20

N (Total) 108

Percent 13.56%

PERFORMANCE ON 1ST FOUR TESTS AND PRE-TEST

Class		N*	P.T.	1	2	3	4
3346	Math A	5	43.3	74.0	72.3	60.0	57.5
	Class	20	39.7	77.5	75.7	66.4	53.5
	Total	103	37.5	80.6	79.3	71.1	62.2
3347	Math A	5	43.4	85.6	81.0	79.0	80.0
	Class	24	39.7	82.8	82.9	77.6	62.1
	Total	103	73.5	80.6	79.3	71.1	62.2
3348	Math A	2	38.5	80.0	57.5	37.5	50.0
	Class	17	40.2	83.3	79.7	70.9	69.2
	Total	103	37.5	80.6	79.3	71.1	62.2
3349	Math A	2	16.5	80.0	80.0	62.5	65.0
	Class	18	35.9	78.7	79.4	69.4	55.9
	Total	103	37.7	80.6	79.3	71.1	62.2
7534	Math A	3	26.7	78.8		65.5	60
	Class	11	32.6	79.4	78.8	81.5	66.7
	Total	103					
7535	Math A	3	48.7	74.7	83.3	50.0	80.0
	Class	13	33.1	81.8	78.3	63.3	73.3
	Total	103	37.5	80.6	79.3	71.1	62.2

* The N given in each case (except Math A) declines slightly due to drop-outs. See page 30.

TABLE V

PERFORMANCE IN THE THREE AREAS

The scores in the three areas (General Math, Algebra, and Applied Geometry) were accumulated for each area and for all criterion test. General Math involved four tests, Algebra and Applied Geometry, two tests each.

Fall - 1961-62 Tests	CONTROL	MACHINE	POCKETSCHOOL	TRAD. W/ OBJECTIVES	EVENING	EVENING
Gen. Math Total	5695	7302	4389	4821	2909	3246
N	21	24	15	17	9	11
Mean	271	304	293	284	312	295
Algebra Total	2275	3089	2160	2030	1025	680
N	18	22	15	16	7	6
Mean	128	143	143	139	146	113
Applied Geom. Total	1865	2172	1435	1785	890	940
N	18	22	13	16	7	7
Mean	103	98	110	113	127	134
All 8 Tests Total	9122	11987	7390	8562	4202	3422
N	18	22	13	16	7	6
Mean	507	545	568	535	586	570

TABLE VI

PERFORMANCE IN THE THREE AREAS

As in the fall classes, the test scores in the areas of General Math, Algebra, and Geometry were accumulated for the spring classes.

Spring 1961-62 TESTS	Fall Control	Non-Conventional	Machine	Conventional	Pocketschool	Even
General Math						
Total	5695	7748	7591	3833	2903	6005
N	21	29	30	13	10	19
Mean	271	267	253	295	290	316
Algebra						
Total	2275	3193	2714	1836	1368	2102
N	18	24	23	13	10	15
Mean	128	133	118	141	137	140
Geometry						
Total	1865	2479	2180	1287	831	2224
N	18	20	27	12	8	19
Mean	103	124	81	107	104	117
All 8 Tests						
Total	9122	10622	11875	6359	4409	8866
N	18	20	27	12	8	15
Mean	507	531	440	530	551	591

TABLE VII

Test score performances of the four quartile groups as based on national norms. - Fall - 1961-62

TOTAL MEAN

	Pre-Test	* △	Final	Tests 1-4	Tests 5a & 5b	Tests 5-7
4TH QUARTILE	43.50	16.5	60.00	85.67	88.00	78.40
3RD QUARTILE	44.69	9.31	54.00	74.30	72.29	58.81
2ND QUARTILE	34.06	17.86	51.92	73.59	67.46	51.18
1ST QUARTILE	36.81	7.11	43.92	69.46	62.69	49.96

* △ Growth (difference between pre-test and final)

TABLE VIII

The following compares the mean performance of the three indicated groups on the tests where the programmed text material was entirely applicable to the Pocketschool class.

GROUPS	Test 2	Test 4	Test 5b
MACHINE TAUGHT	85	55	81
POCKETSCHOOL	79	64	74
CONTROL GROUP	78	51	65

TABLE IX

COMPARISON OF CLASS STABILITY

Fall - 1961-62

	CONTROL	MACHINE	POCKETSCHOOL	TRADITIONAL WITH/OBJECTIVES	EVENING	EVENING	TOTAL
Initial Enrollment	27	26	18	21	14	14	120
Final Enrollment	18	22	14	16	7	5	82
Number of Drops	9	4	4	5	7	9	38
Percent of Drops	33.3	15.4	22.2	23.8	50.0	64.3	31.7

TABLE X

GRADE DISTRIBUTION - Fall - 1961-62

	A's			B's			C's			D's			F's
	Range	N	%	Range	N	%	Range	N	%	Range	N	%	Range
Control	814	1	5.55	642-749	5	27.8	412-632	9	50	422	1	5.55	276-382
Machine	690-797	4	18.3	626-674	4	18.3	563-621	11	50	428-572	3	13.4	
Pocketschool	759-814	3	23	655-714	3	23	532-646	4	31	415-505	3	23	
Traditional with Objectives	791	1	6.25	676-719	4	25	537-633	7	43.7	465-510	3	18.75	257
Evening	734-807	2	28.5	559-701	3	43	490-611	2	28.5		0		
Evening	670-715	2	40	621	1	20	541-606	2	40		0		
Total	670-814	13	16	559-749	20	24.7	490-633	35	43.2	415-572	10	12.4	257-382

There were no F grades given in either 3347 or 3348 classes since it was felt such action would be inadvisable due to the nature of the experiment.

TABLE XI

COURSE OUTLINE - POCKETSCHOOL GROUP

U N I T	Read and Work Examples on Pages	W O R K	
		Pages	Problems
Review Math			
Fractions	20-29	29	1
Add. & Subt.	30-31	31	1
Mult. & Division	Pocketschool - Book 4		
Decimals			
Add. & Subt.	51-58	58	2-6
Mult. & Division	Pocketschool Books 1,2,3		
Percentage	108-111	112	10-12
		113	13-35
Ratio & Proportion	126-128	128	1, 2
	Pocketschool-Books, 11, 12		
Powers & Roots	Pocketschool - Books 5,6,7		
Algebra			
Introduction	333-354	339	1a, c, d, e, f
		340-341	7, 11, 12-16
		345	1-4
		349	24-47
Add. & Subt.	355-367	357	1-12
		360-62	All
		364	4, 5, 6
		365	1-6
Simple Equations	Pocketschool - Books 8, 9, 10, 13, 14, 15, 16		
Applied Geometry	162-175	174-75	1-10
Polygon Areas	176-186	178	1-7
		182	1, 5, 6, 15, 16
		186	1, 2, 5, 6
Triangles	189 - 197	191	1-9, 15, 23-25
	205 - 210	200	13-15
		209	6, 11, 13, 14
Circles	218-231	222	1-4
		224	1, 2, 3, 6, 7
"	228	228	1c, f, h, 5, 6, 10, 11, 13, 16, 17, 29, 31
Prisms	277-283	281	1, 3, 5-12, 14, 15, 17-19, 22, 28
Cylinders	289-305	293	2, 4, 10, 11, 17, 20, 30, 35, 47, 65
Spheres	317-318	321	3, 6, 9, 12, 19, 33

IDD:nm/s

TABLE XII

Fall Semester Data

Variable	F - ratio	Significance at 1% or 5%
1. Pre-test	0.79	No
2. (fractions)	0.96	No
3. (decimals)	0.70	No
4. (per cent)		
5. (ratio and proportion)	1.23	No
6. General Math Total Scores	1.09	No
7. (algebra)	2.10	No
8. (algebra)	1.31	No
9. Algebra Total Scores	1.10	No
10. (geometry)	0.53	No
11. (geometry)	1.55	No
12. Geometry Total Scores	1.43	No
13. Criterion Total Scores	0.85	No
14. Final Test	1.12	No
15. All Test Total Scores	0.95	No
16. Semester Grades	1.08	No
17. Growth (t-score)	2.83	<1% (see pg.53)
18. Age	0.43	No
19. Semesters of High School Math	3.02	1% level
20. Average Grade in High School Math	1.06	No
21. S. C. A. T. - Verbal	0.64	No
22. S. C. A. T. - Quantitative	0.32	No
23. S. C. A. T. - Total	0.44	No

TABLE XIII

T - TEST ANALYSIS

PRE-TEST

FALL

Groups	t-ratios	d.f.	Significance
Control - *Machine	0.4801	50	No
Control - *Pocketschool	0.5886	32	No
*Control - Trad. W/Objectives	0.3890	44	No

SPRING

*Fall Control - Non-Conventional	1.6131	55	10% < t < 5%
*Fall Control - Machine	2.1965	55	5% < t < 2%
*Fall Control - Conventional	1.0410	37	t < 10%
*Fall Control - Pocketschool	1.0866	35	10% < t < 5%

S. C. A. T. TOTAL

SPRING

Fall Control - Non-Conventional	0	44	None
*Fall Control - Machine	4.4528	48	t > 0.1%
Fall Control - *Conventional	0.3238	28	No
*Fall Control - Pocketschool	0.9044	28	No
*Non-Conventional - Machine	5.2021	50	t > 0.1%
Non-Conventional - *Pocketschool	2.9764	34	t > 1%

GENERAL MATH

SPRING

*Fall Control - Non-Conventional	0.3333	48	No
*Fall Control - Machine	0.8535	47	No
Fall Control - *Conventional	1.2054	32	No
Fall Control - *Pocketschool	0.8652	29	No
*Non-Conventional - Machine	1.0000	55	No
*Conventional - Machine	2.4438	39	2% < t < 1%
*Pocketschool - Machine	1.9595	43	5% < t < 2%

ALGEBRA

SPRING

Fall Control - *Non-Conventional	0.3955	40	No
*Fall Control - Machine	0.8721	39	No
Fall Control - *Conventional	0.6513	29	No
Fall Control - *Pocketschool	0.5537	26	No
*Non-Conventional - Machine	1.5855	45	t < 10%
Machine - *Conventional	2.1598	34	5% < t < 2%
Machine - *Pocketschool	1.7273	31	10% < t < 5%
Non-Conventional - *Conventional	1.4415	35	t < 10%
Non-Conventional - *Pocketschool	1.4157	32	t < 10%

TABLE XIV

TABLE XIV (Cont.)

GEOMETRY

SPRING

Fall Control -* Non-Conventional	1.6493	36	t < 10%
*Fall Control - Machine	1.6396	37	t < 10%
Fall Control -* Conventional	0.2405	28	No
Fall Control -* Pocketschool	0.0557	24	No
*Non-Conventional - Conventional	1.1417	30	No
*Non-Conventional - Pocketschool	1.2626	26	No
*Conventional - Pocketschool	0.1433	18	No
Machine -* Non-Conventional	3.5613	39	t > 0.1%
Machine -* Conventional	1.6511	31	t < 10%
Machine -* Pocketschool	1.3355	27	t < 10%

GROWTH

Fall Control -* Non-Conventional	0.4545	38	No
Fall Control -* Machine	2.1307	32	5% < t < 2%
Fall Control -* Conventional	1.1777	27	No
Fall Control -* Pocketschool	2.5423	24	2% < t < 1%
*Machine - Non-Conventional	0.5469	38	No
*Machine - Conventional	0.4288	27	No
Machine -* Pocketschool	0.2642	24	No
Non-Conventional -* Pocketschool	0.6934	30	No
Conventional -* Pocketschool	0.5676	19	No

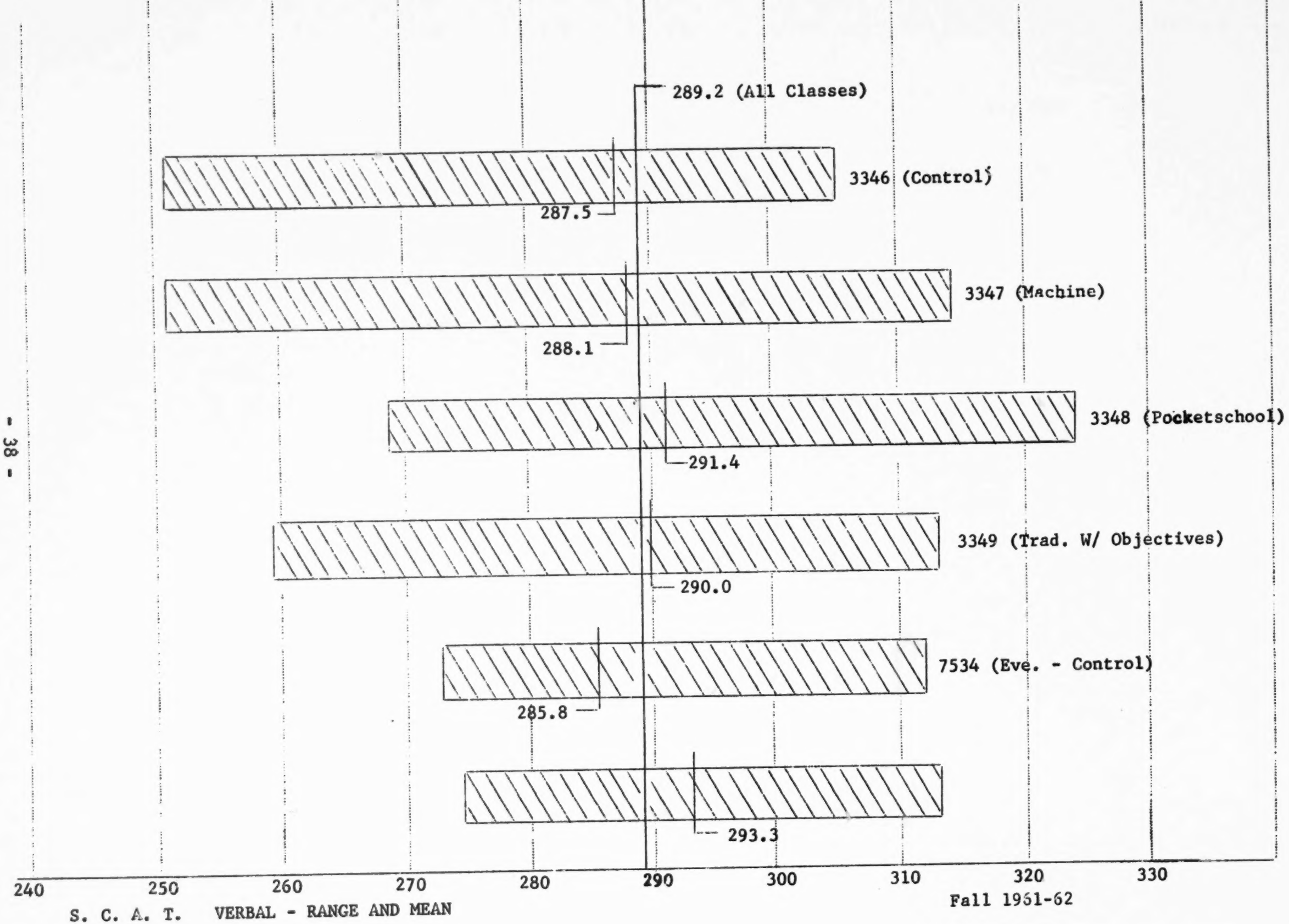
* The group with the highest mean in the comparison.

TOTAL COST OF EXPERIMENT

Phase I			
	Salary	480.00	
	Equipment and Supplies	20.00	
	Programmed Material	226.15	
	Consultant	160.00	
	Teaching Machine Rental	160.00	
	Typewriter (Math) Rental	90.00	1,136.15
Phase II			
	Salary	896.00	
	Typist	164.05	
	Equipment and Supplies	28.30	
	Programmed Material	27.38	1,115.73
Phase III			
	Salary - Supervision	6,445.34	
	Secretary - Clerk	999.08	
	Instruction	2,077.32	
	Equipment and Supplies	43.87	
	Machines and Programs	5,851.42	
	Printing Report (Est.)	495.00	
	Editing Report	294.84	
	Machine Installation	46.86	
	Telephone	40.85	16,294.58
		Total	18,546.46

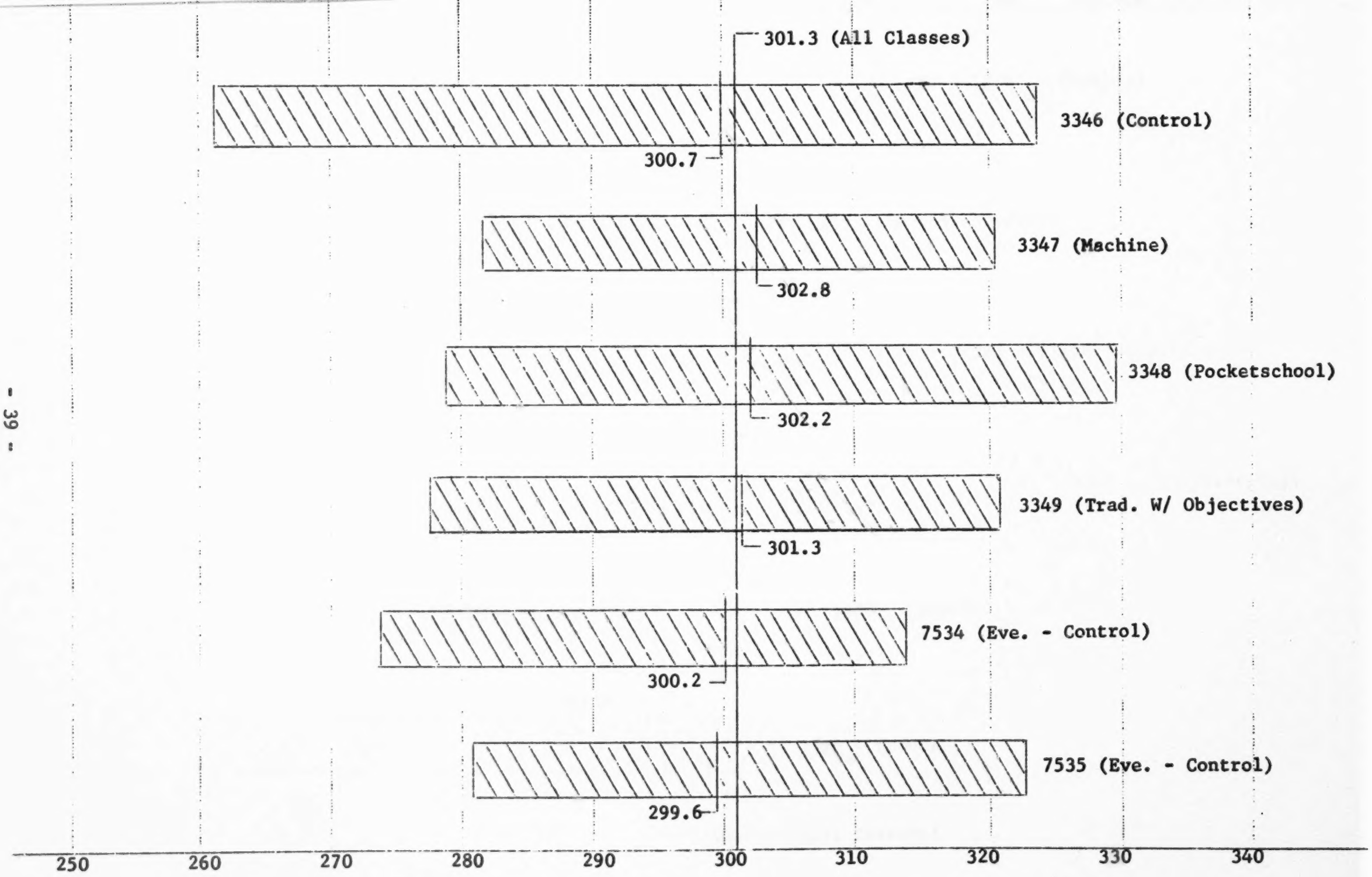
TABLE XV

CHARTS



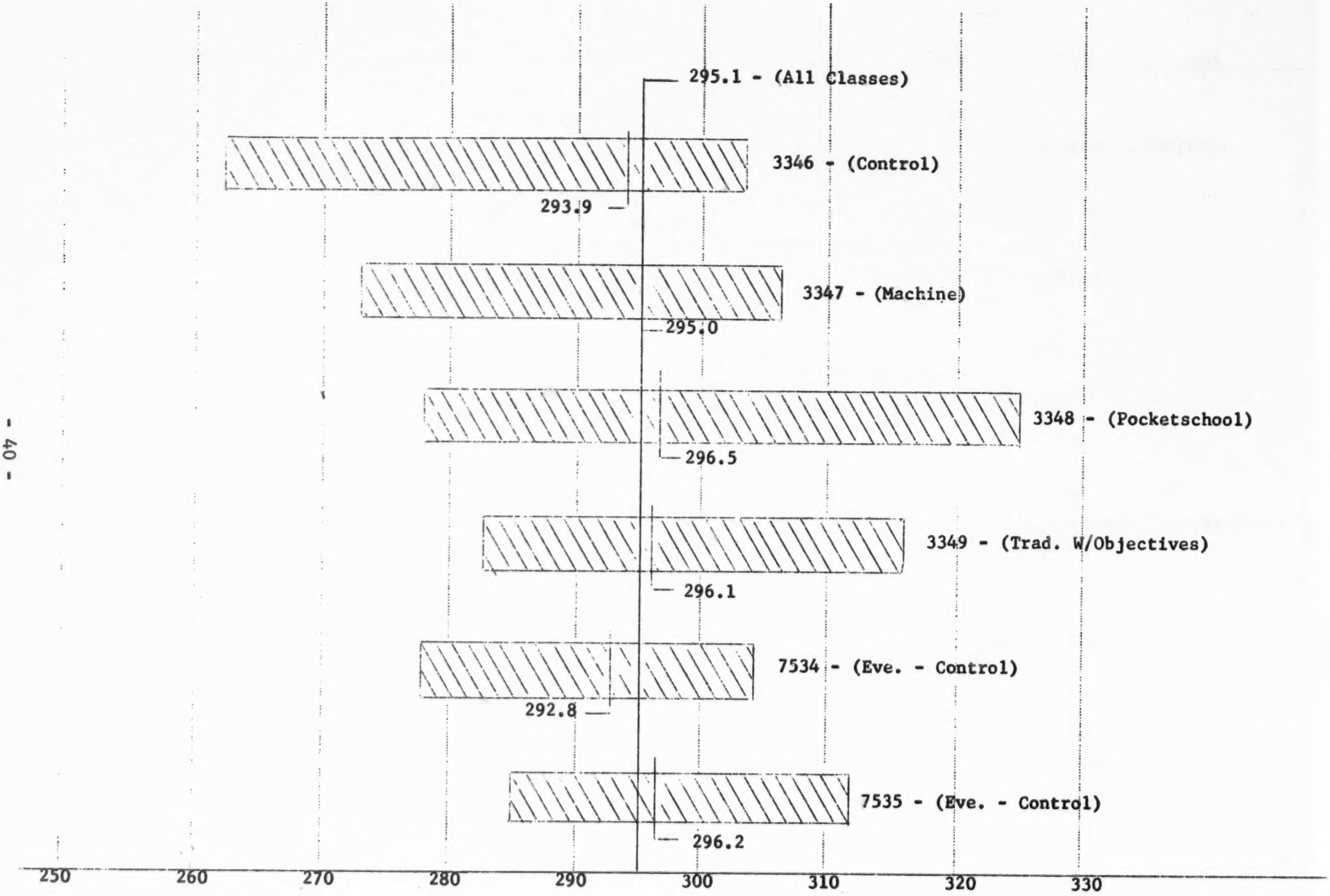
S. C. A. T. VERBAL - RANGE AND MEAN

Fall 1961-62



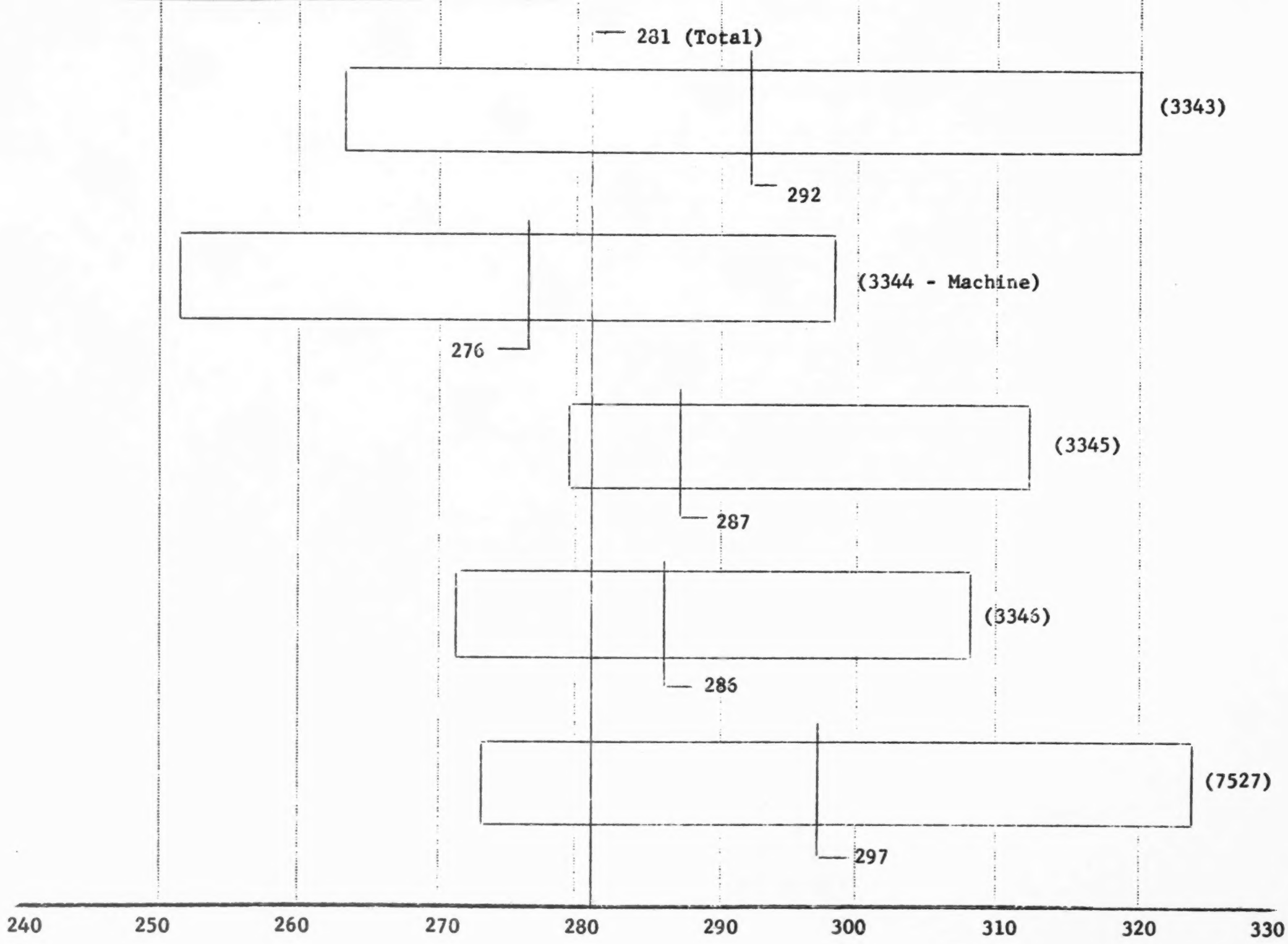
S. C. A. T. Q - RANGE AND MEAN

Fall 1961-62



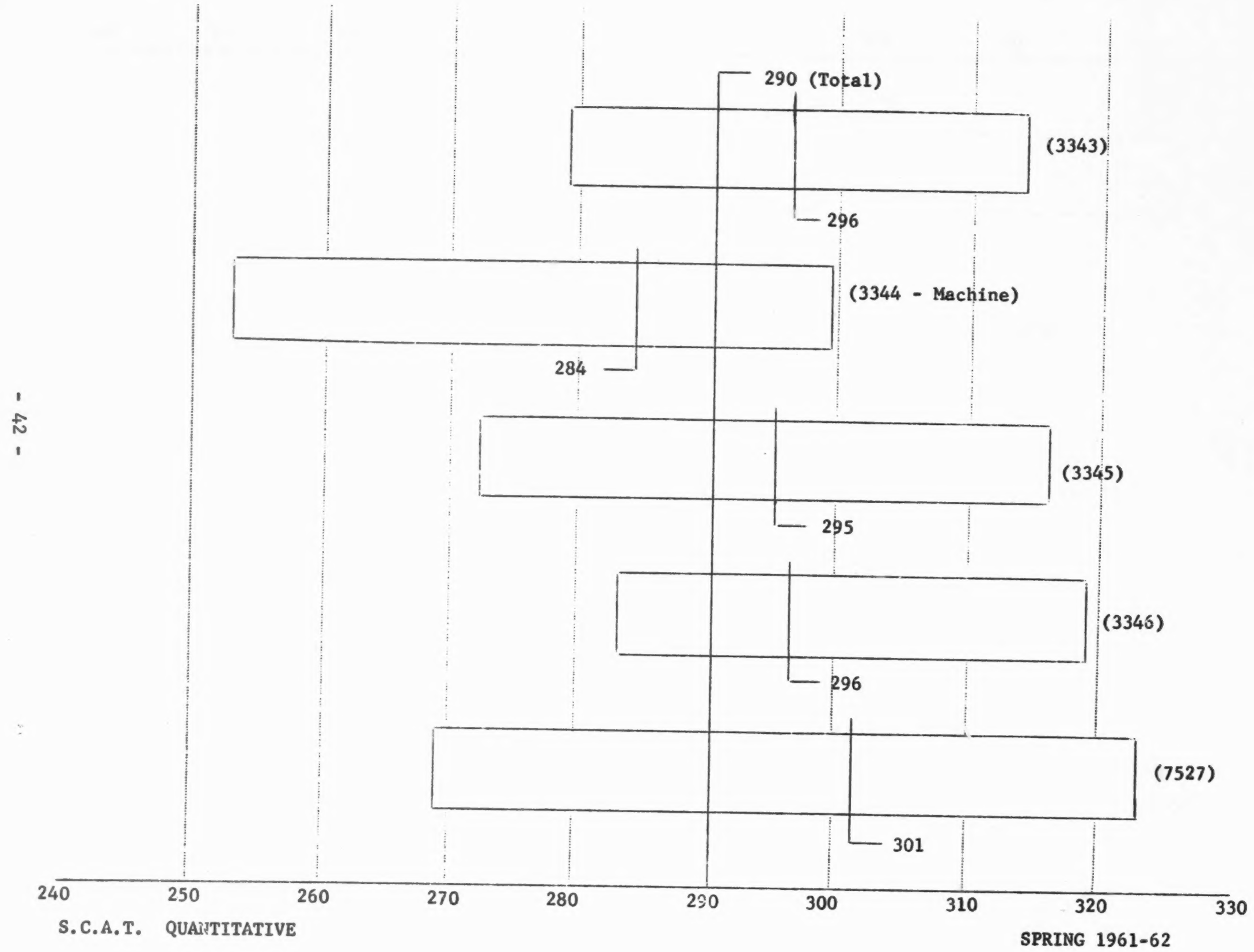
S. C. A. T. TOTAL RANGE AND MEAN

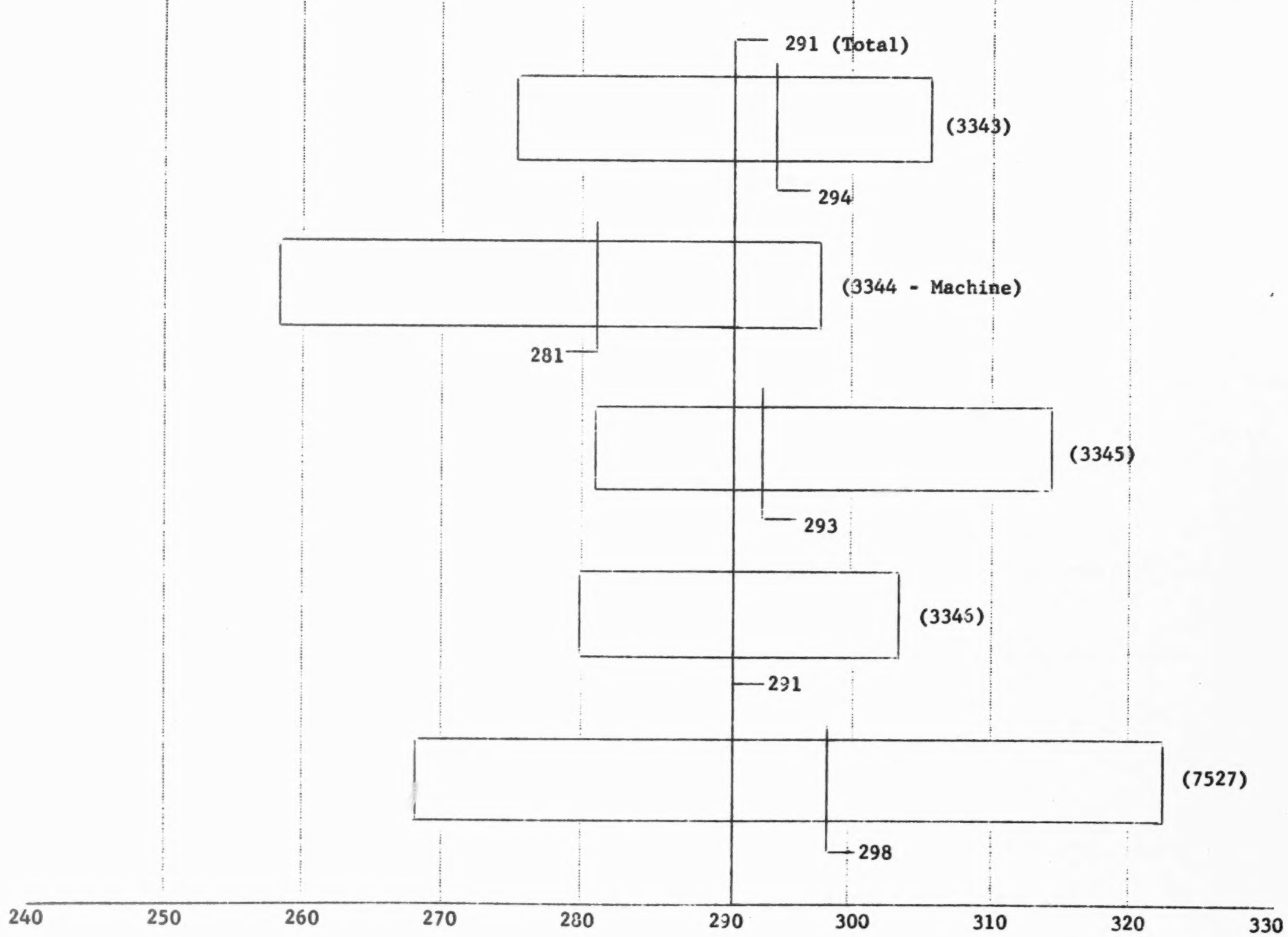
Fall 1961-62



S.C.A.T. VERBAL - RANGE AND MEAN

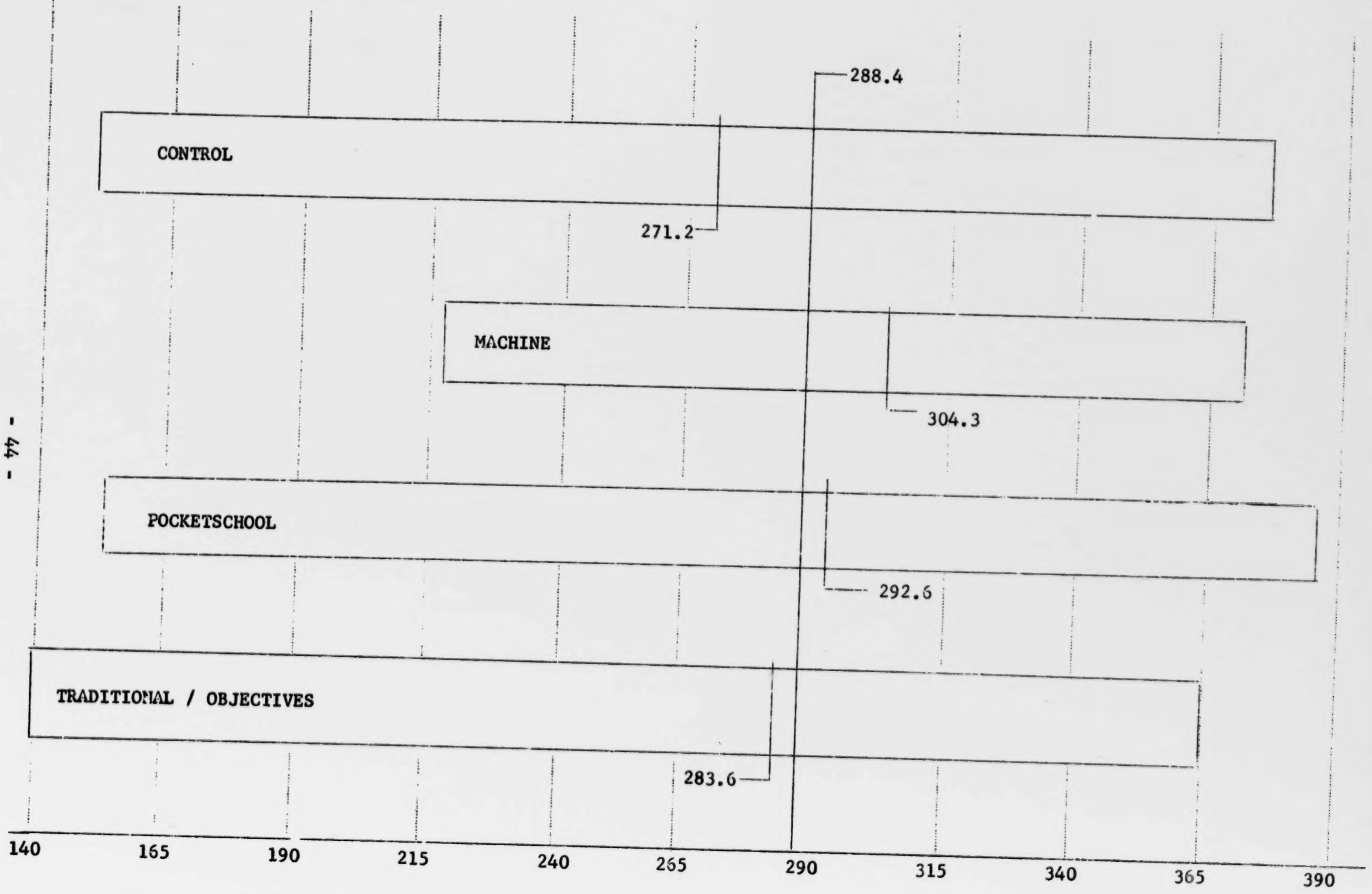
SPRING 1961-62


290 (Total)
(3343)
296
(3344 - Machine)
284
(3345)
295
(3346)
296
(7527)
301
240
250
260
270
280
290
300
310
320
330
S.C.A.T. QUANTITATIVE
SPRING 1961-62



S.C.A.T. TOTAL - RANGE AND MEAN

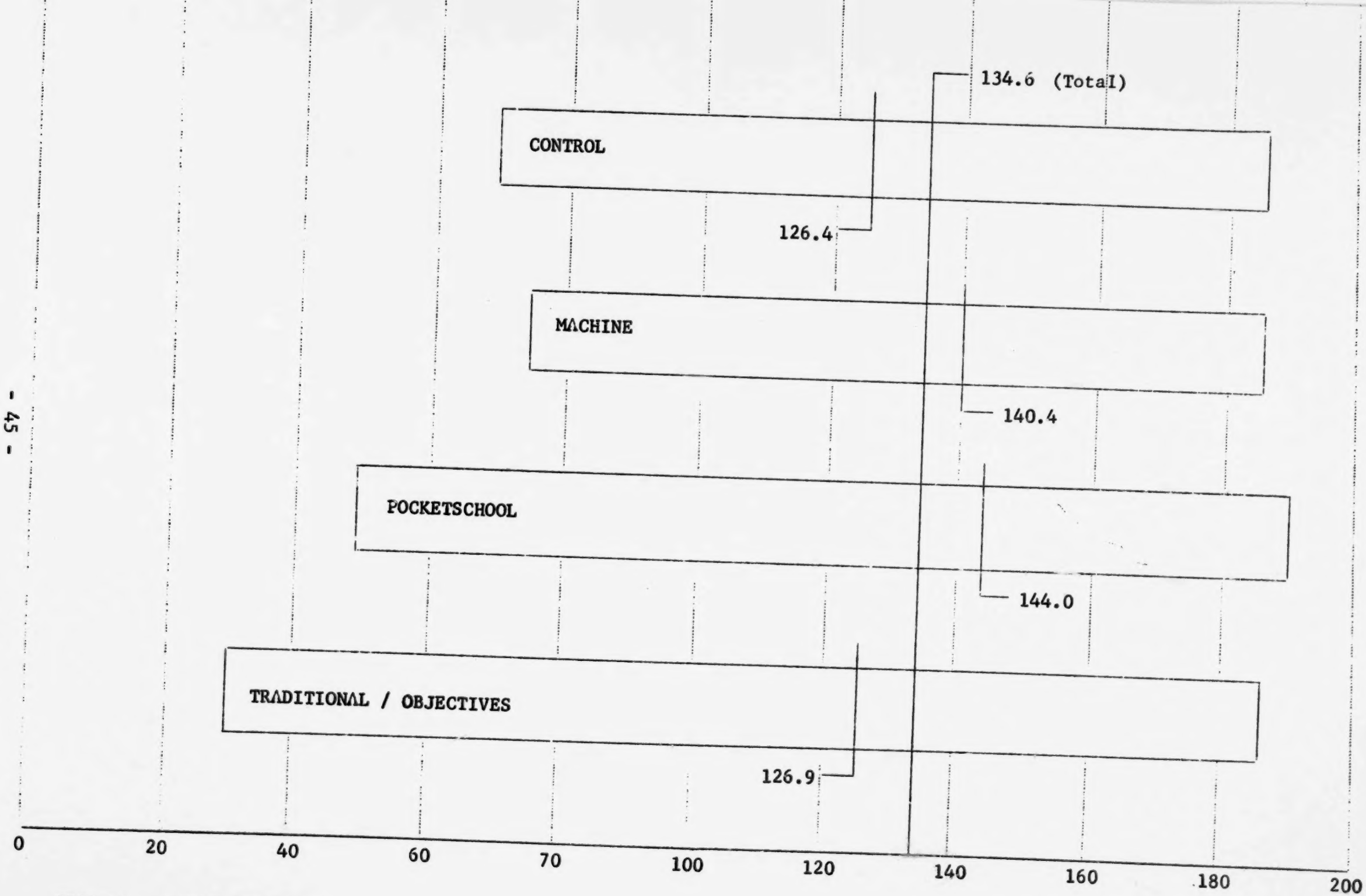
SPRING 1961-62



GENERAL MATH RANGE AND MEAN

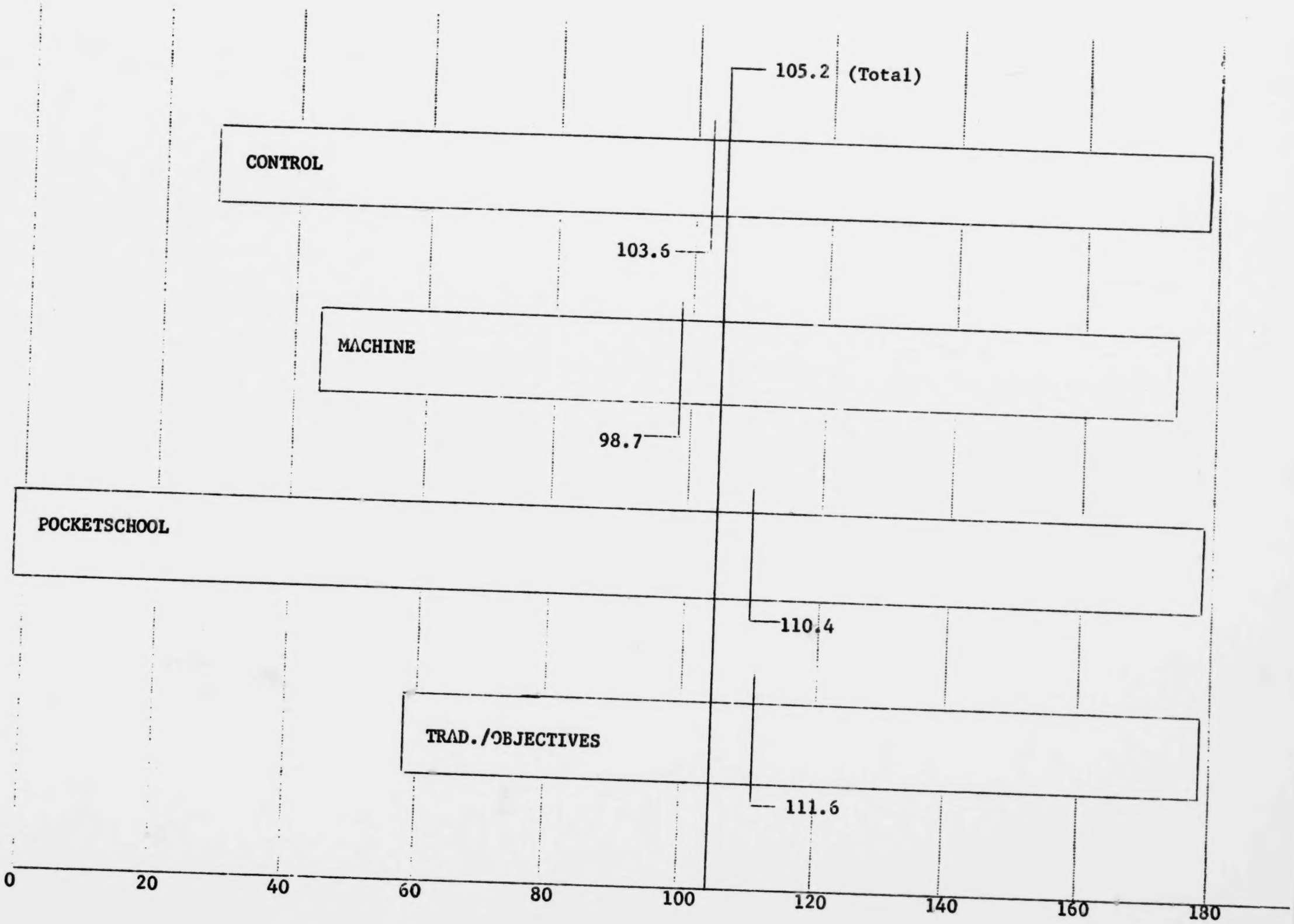
FALL 1961-62

2



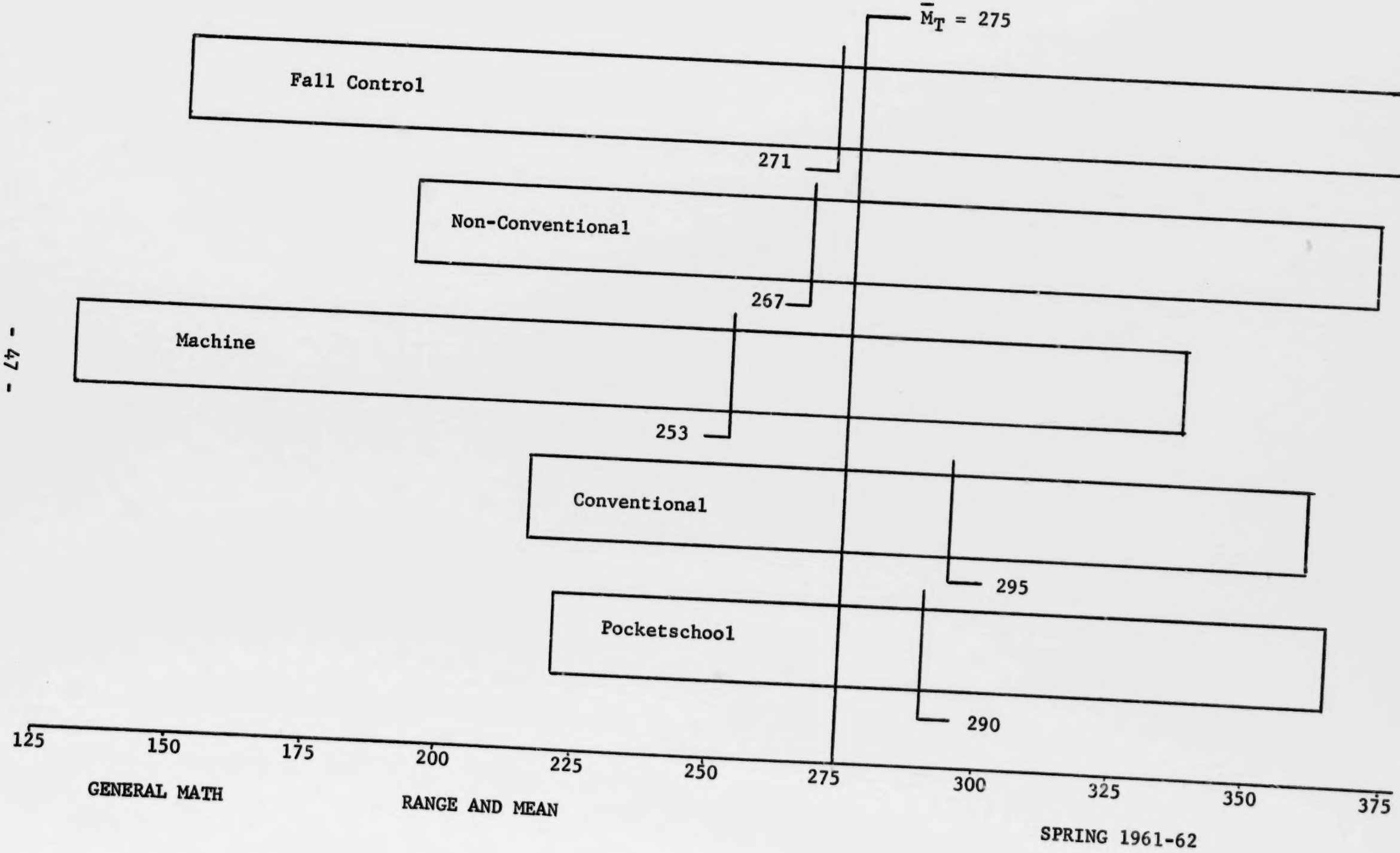
ALGEBRA - RANGE AND MEAN

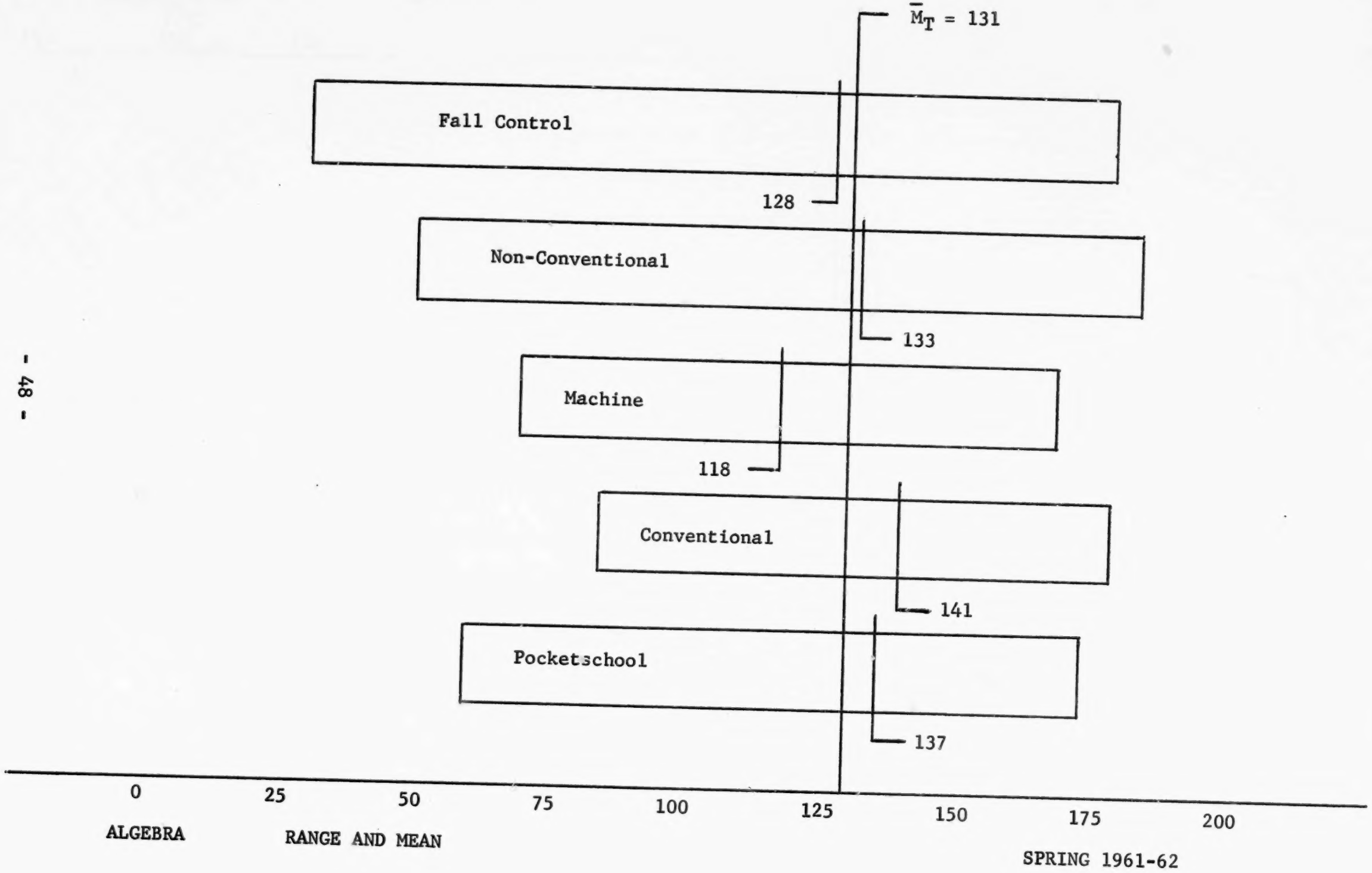
FALL 1961-62

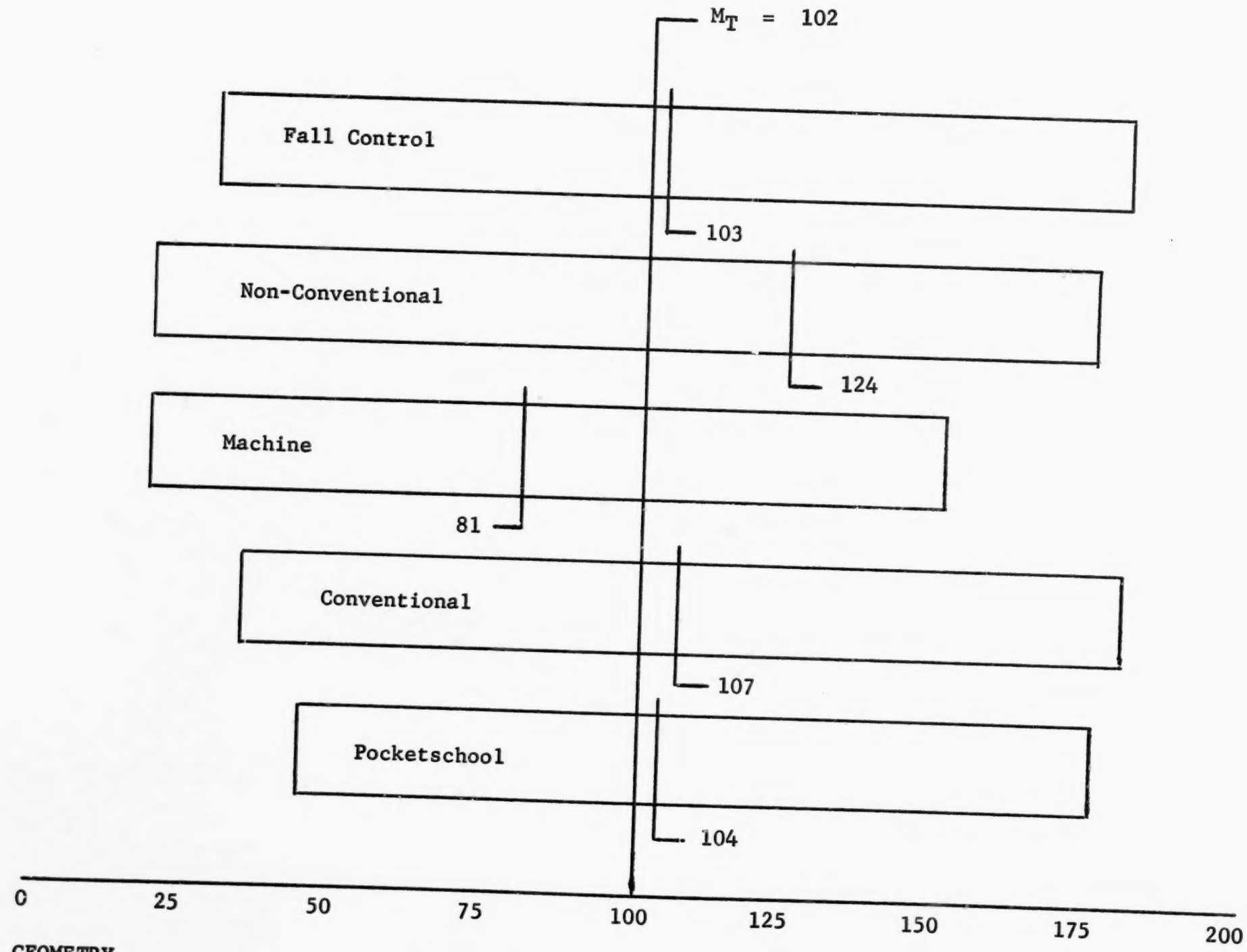


GEOMETRY - RANGE AND MEAN

FALL 1961-62


$\bar{M}_T$ = 275
Fall Control
271
Non-Conventional
267
Machine
253
Conventional
295
Pocketschool
290
125
150
175
200
225
250
275
300
325
350
375
GENERAL MATH
RANGE AND MEAN
SPRING 1961-62

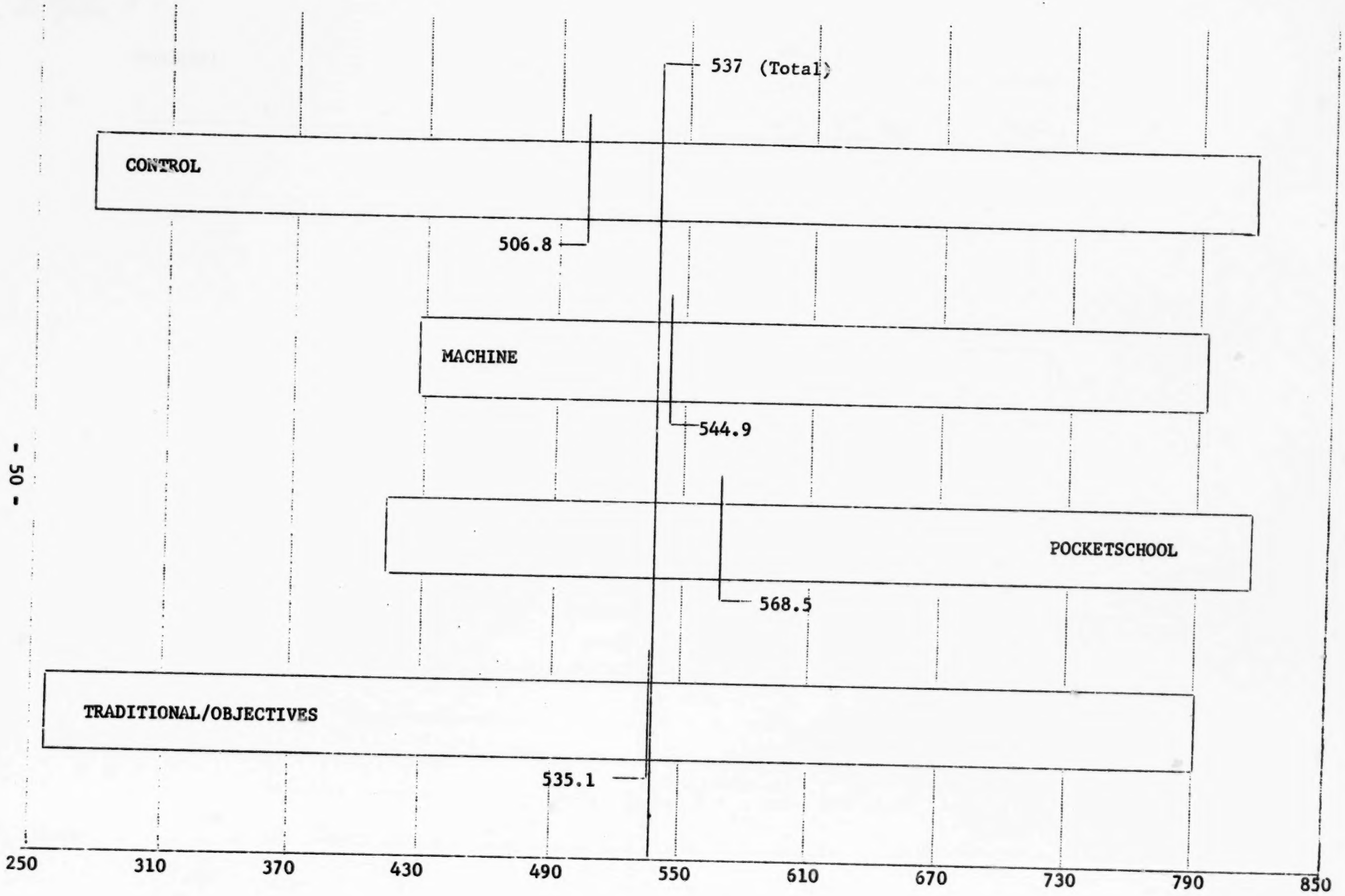

$\bar{M}_T$ = 131
Fall Control
128
Non-Conventional
133
Machine
118
Conventional
141
Pocketschool
137
0
25
50
75
100
125
150
175
200
ALGEBRA
RANGE AND MEAN
SPRING 1961-62



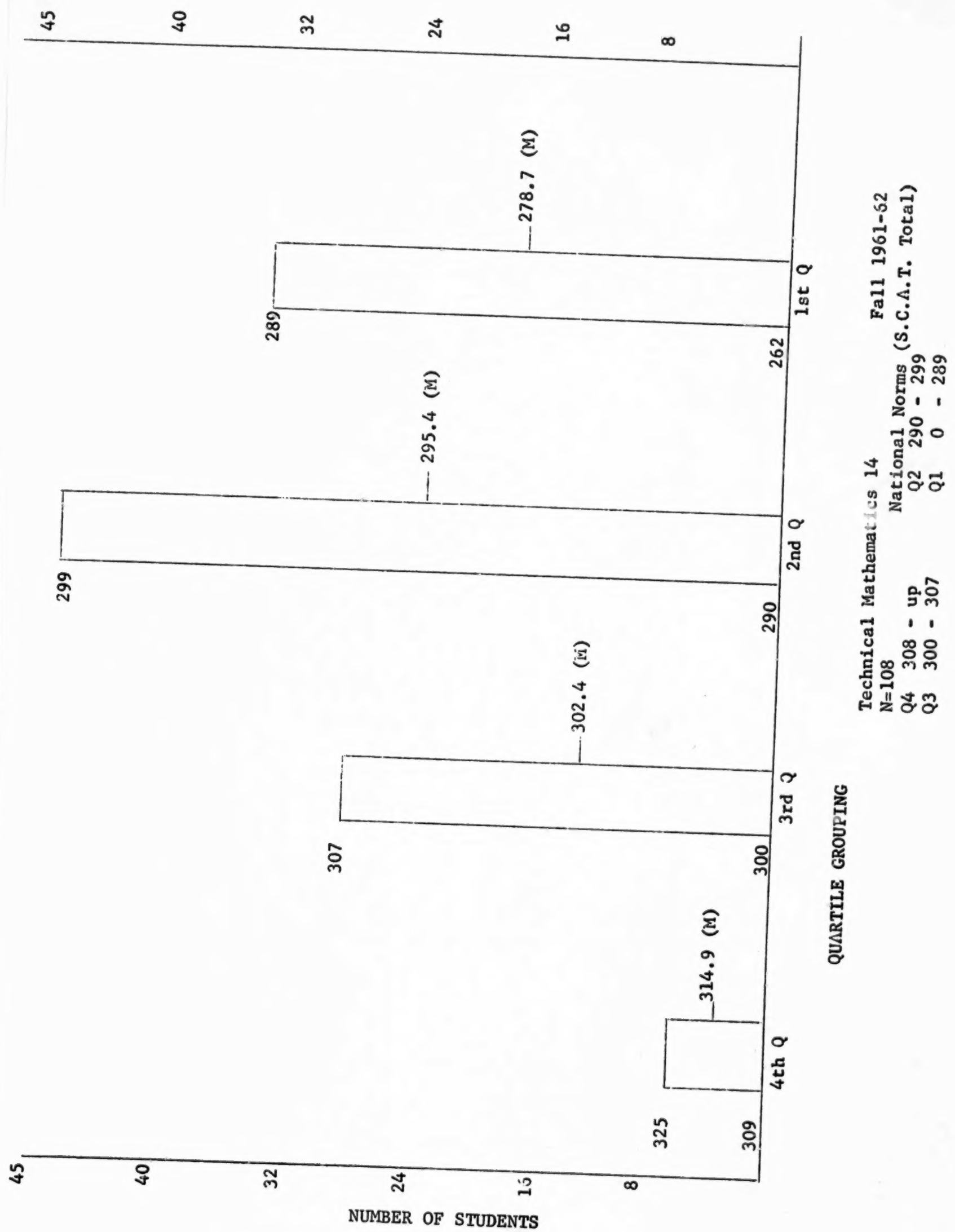
GEOMETRY

RANGE AND MEAN

SPRING 1961-62



3 A R E A S - R A N G E A N D M E A N



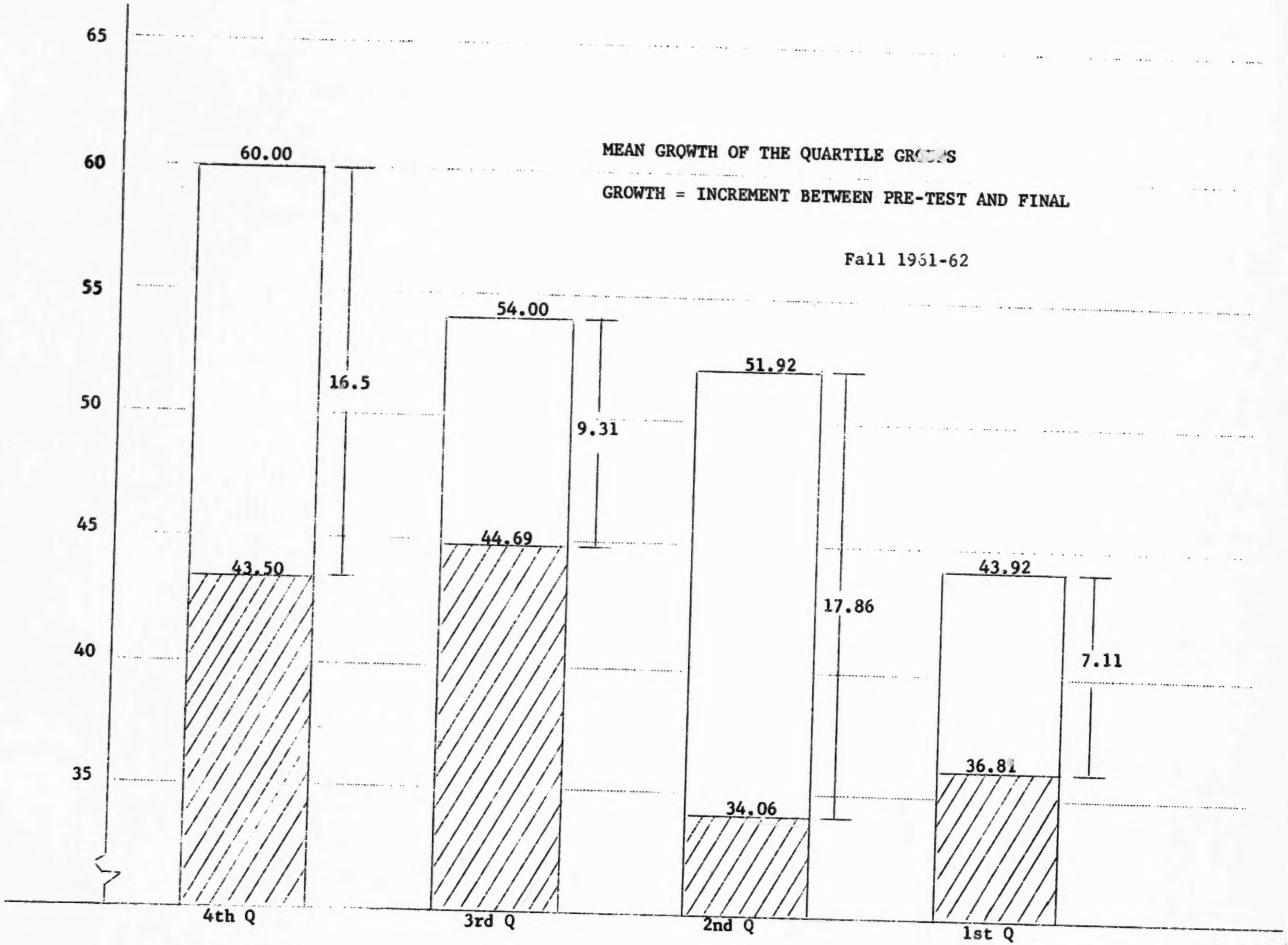
Technical Mathematics 14
N=108
Q4 308 - up
Q3 300 - 307

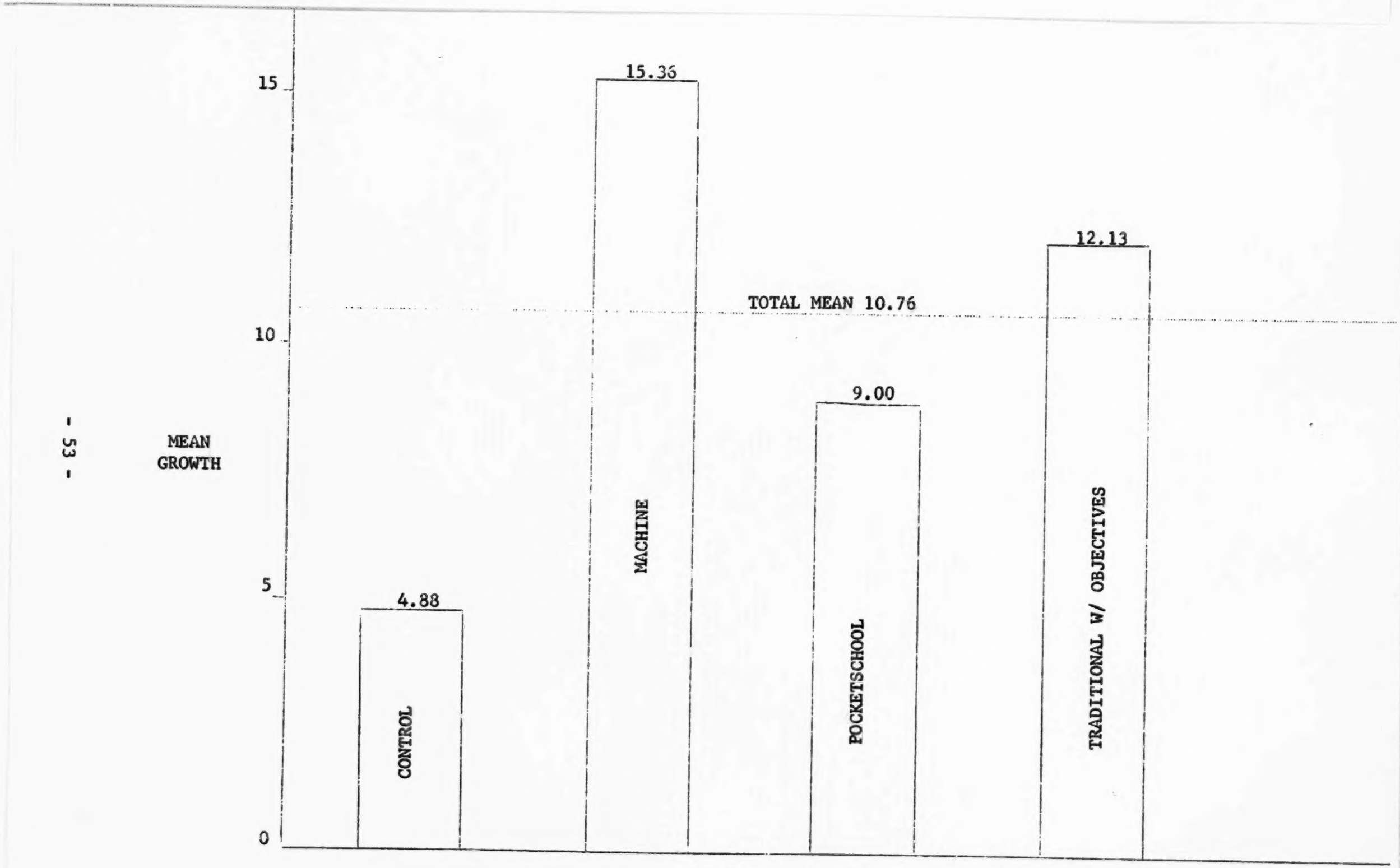
Fall 1961-62
National Norms (S.C.A.T. Total)
Q2 290 - 299
Q1 0 - 289

MEAN GROWTH OF THE QUARTILE GROUPS

GROWTH = INCREMENT BETWEEN PRE-TEST AND FINAL

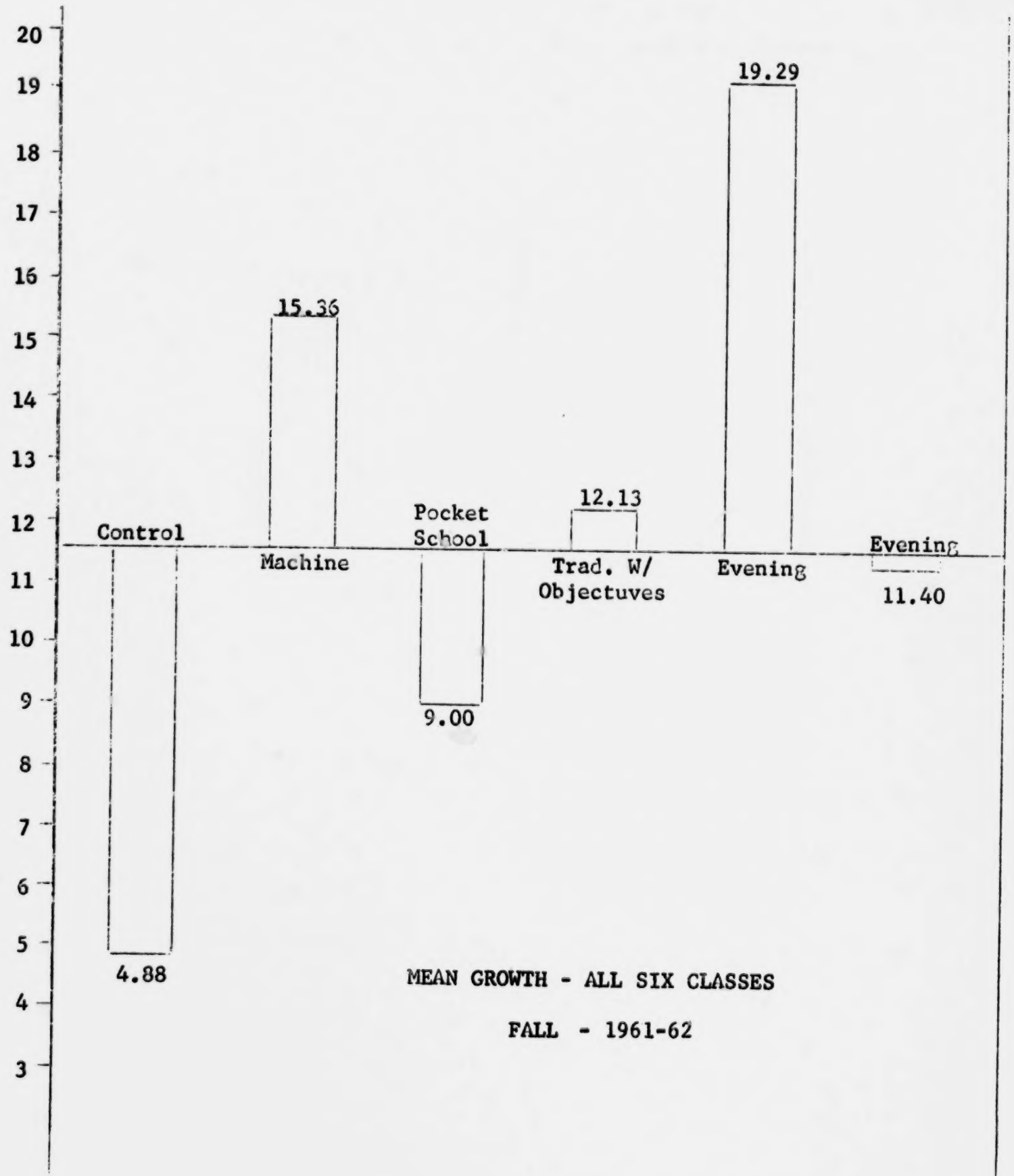
Fall 1961-62





MEAN GROWTH - FOUR DAY CLASSES
FALL 1961-62

TOTAL MEAN 11.55



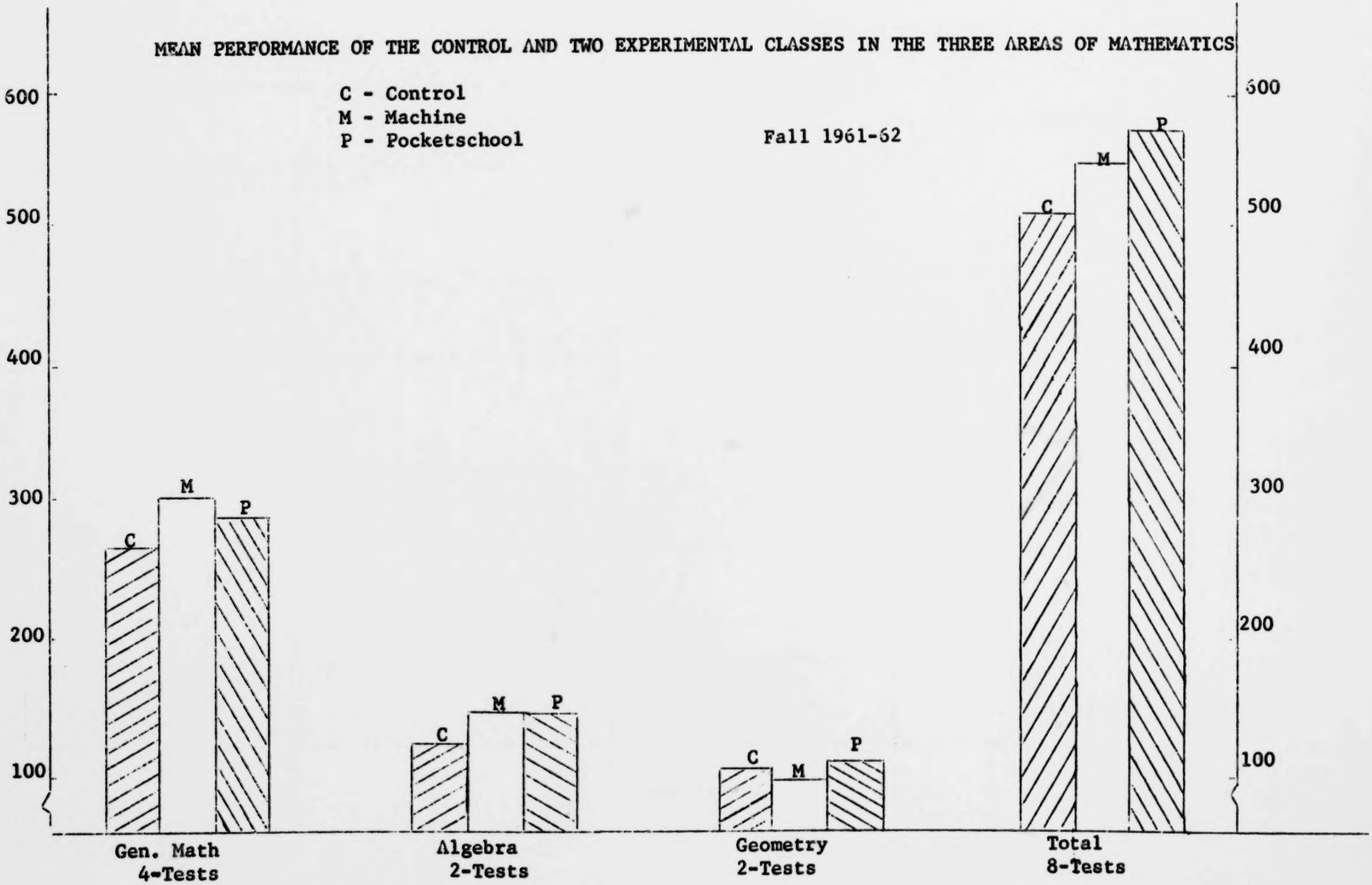
MEAN GROWTH - ALL SIX CLASSES

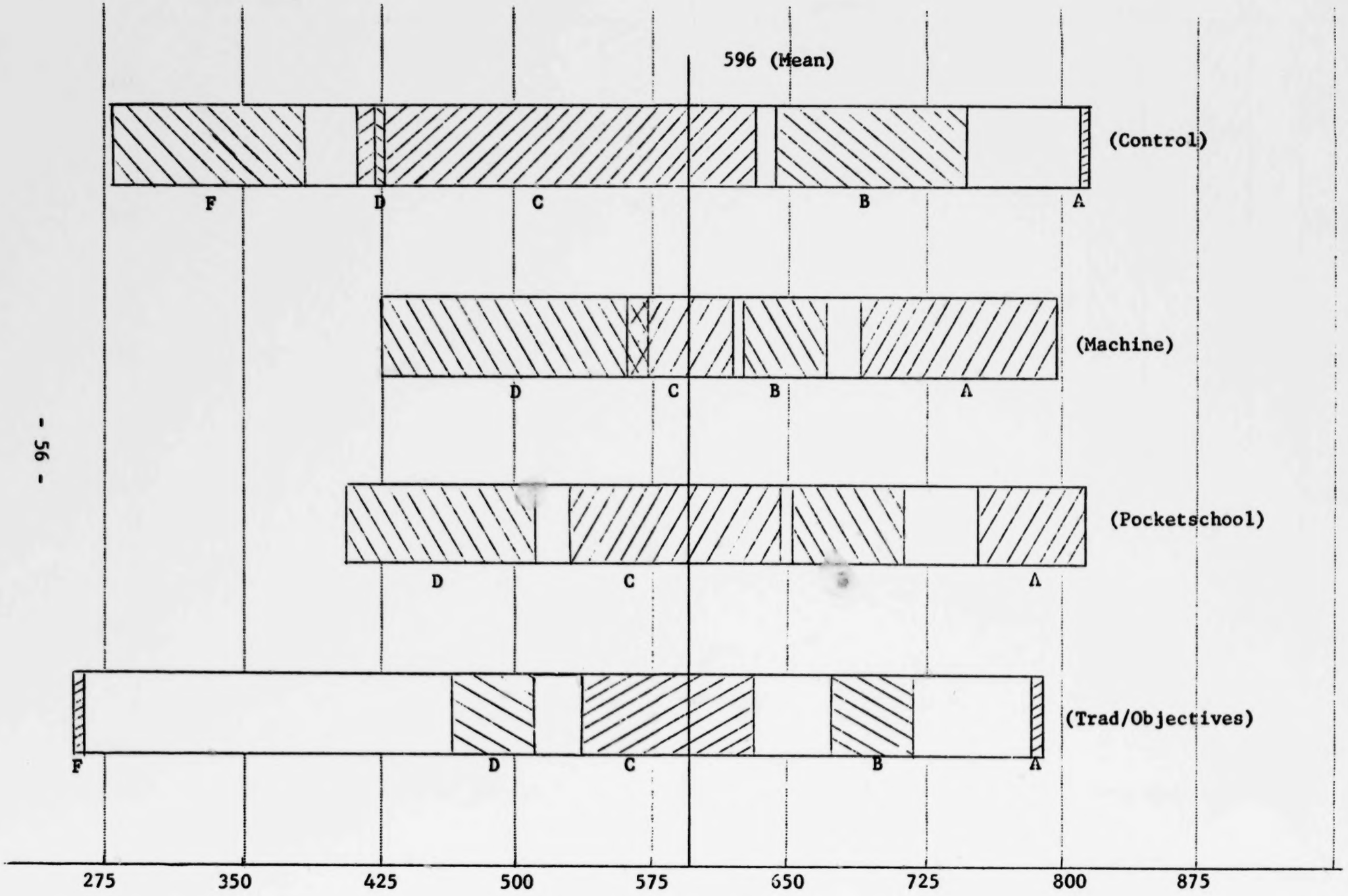
FALL - 1961-62

MEAN PERFORMANCE OF THE CONTROL AND TWO EXPERIMENTAL CLASSES IN THE THREE AREAS OF MATHEMATICS

C - Control
M - Machine
P - Pocketschool

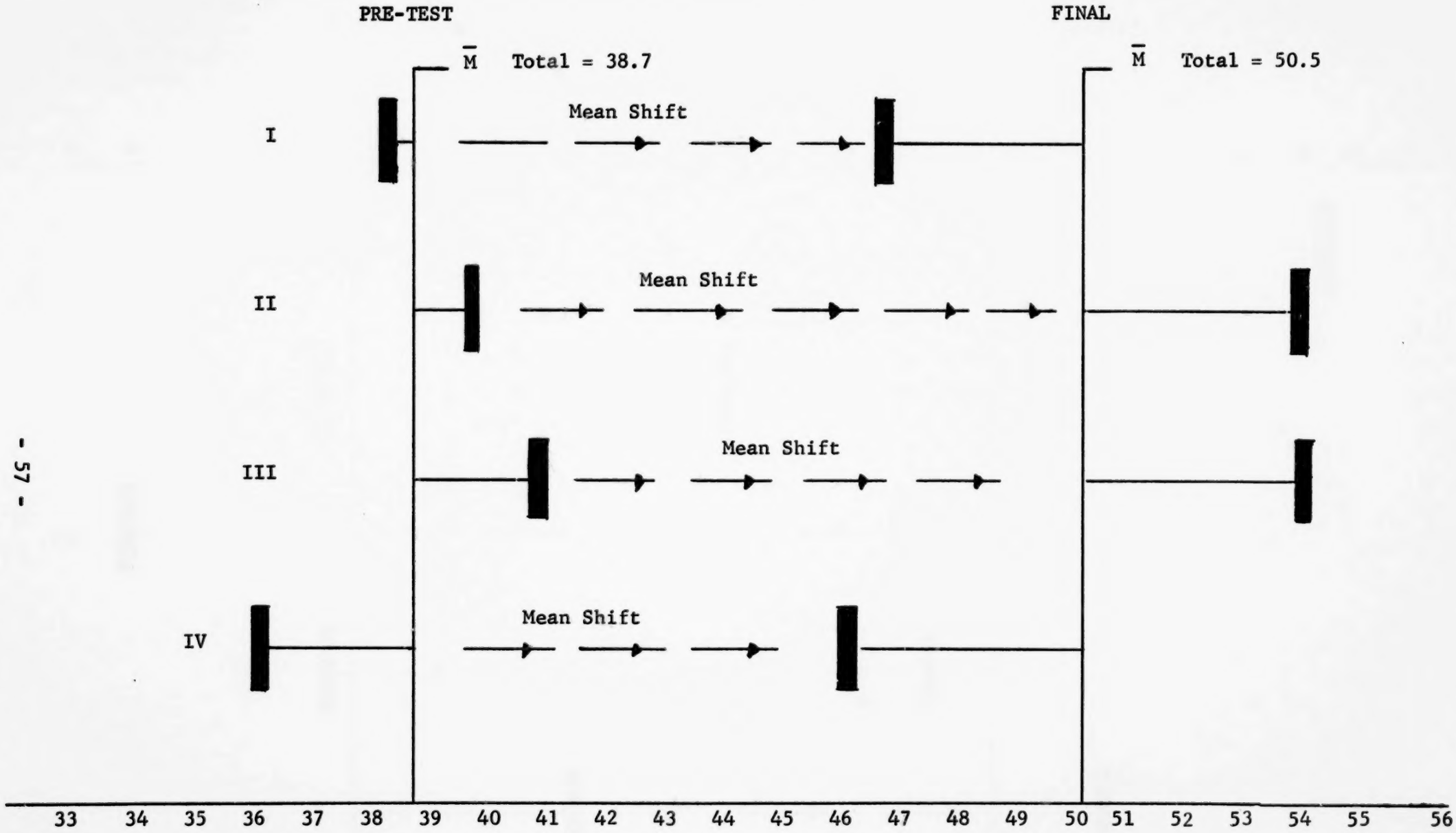
Fall 1961-62



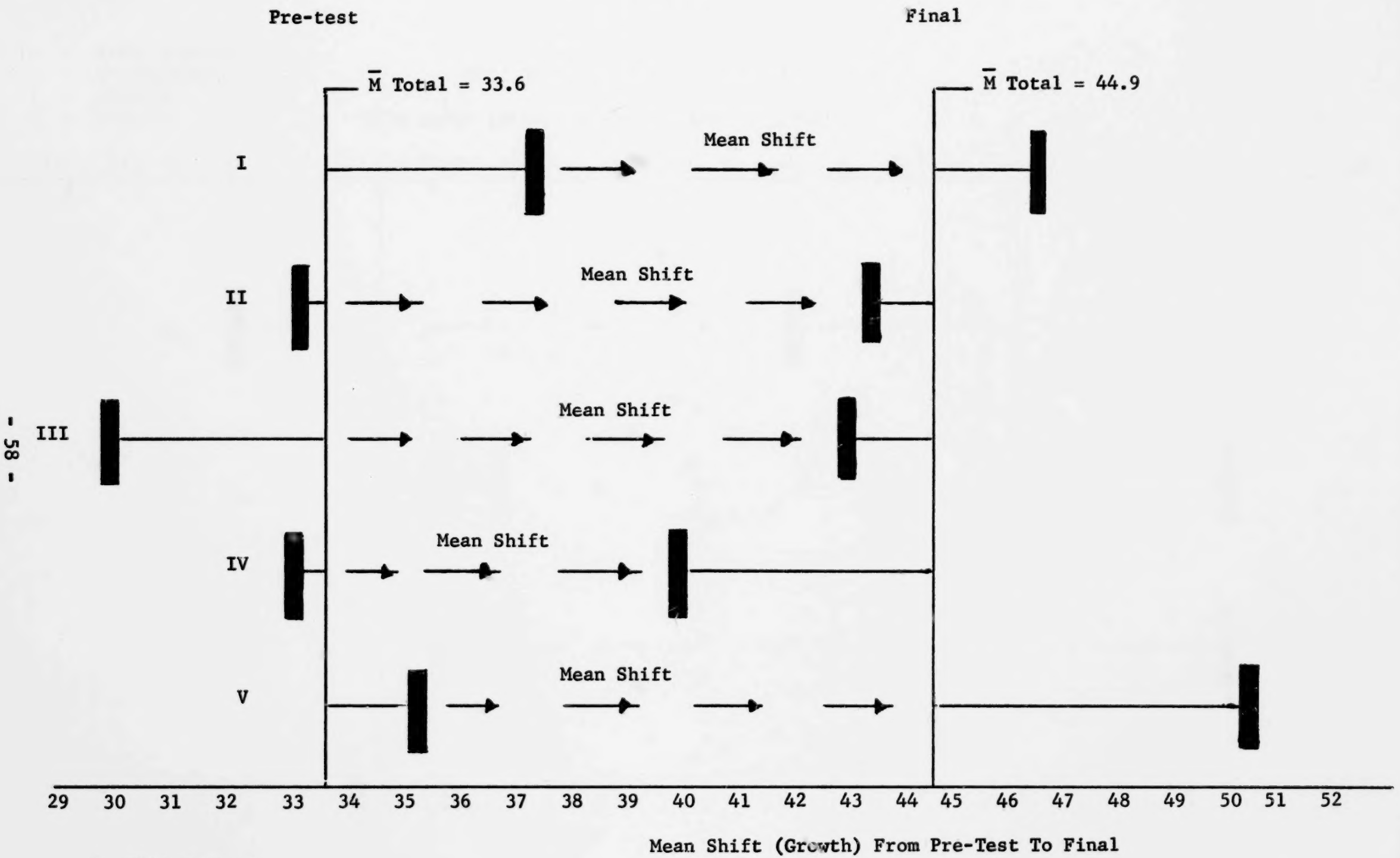


COMPARATIVE GRADE DISTRIBUTION

FALL 1961-62



I - Control
II - Machine
III - Pocketschool
IV - Trad. W/Objectives



I Fall Control
II Non-Conventional
III Machine
IV Conventional
V Pocketschool

Spring Classes 1961-62